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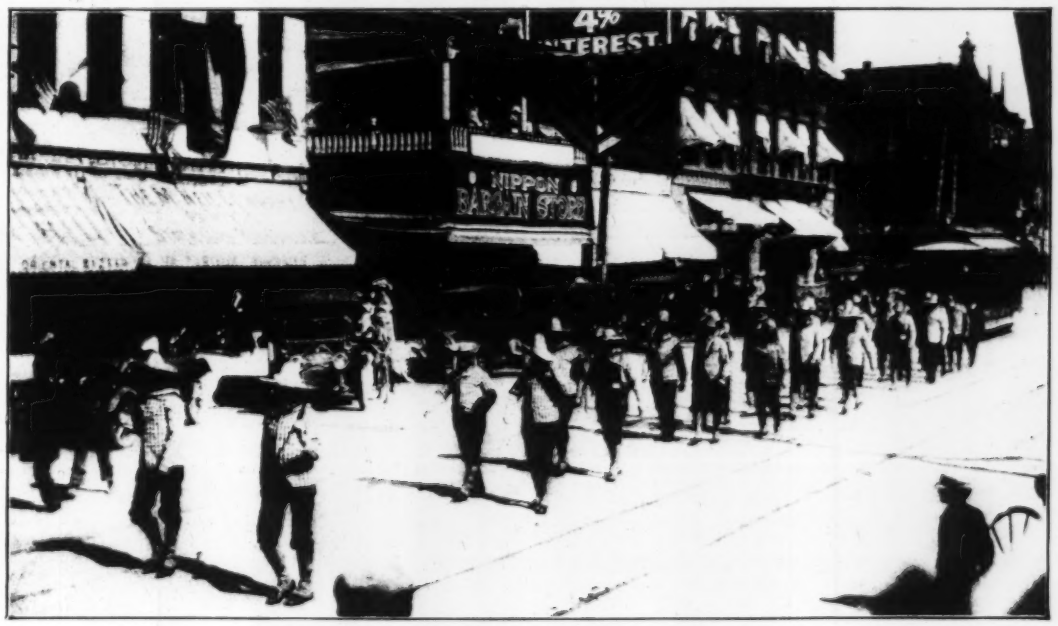

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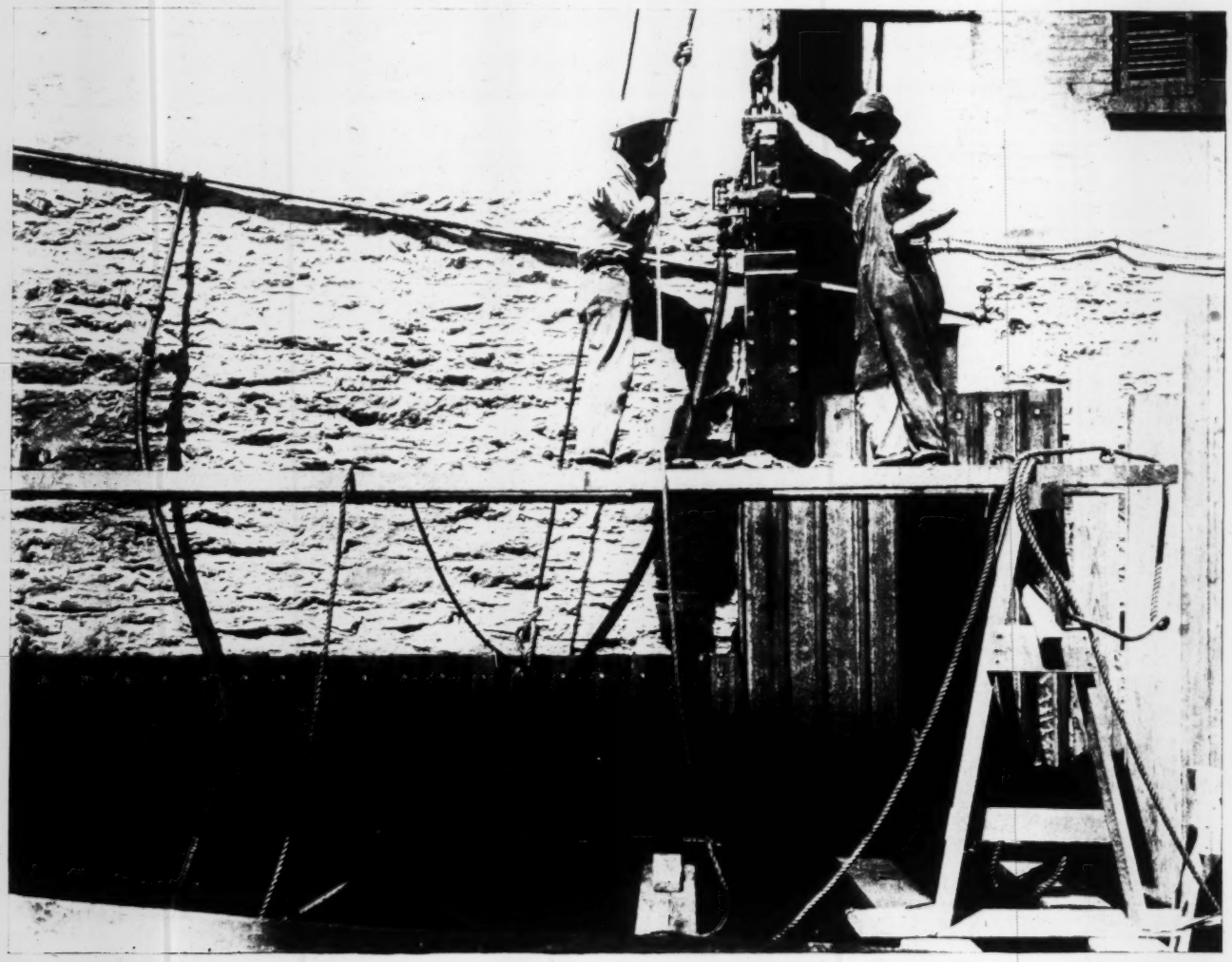

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Engineering News

CHARLES WHITING BAKER, *Editor*

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What The Buyer Needs To Know

Number Sixteen

Many of you who read this page will be surprised to know that thousands and thousands of dollars have been spent in the past few years by manufacturers of machinery and allied lines in what are termed "general magazines."

That is to say, they have advertised to everybody in the hope of hitting somebody.

This would be fine business if they had only to *pay* for what they *hit*.

General magazines must of necessity aim to interest the universe from the world of politics to the world of fashion.

Hence their circulations are tremendous, and their readers as varied in pursuits, aims and occupations as the crowd that watches a circus parade.

Their advertising rates are based upon the *quantity* of circulation. The advertiser pays for *everything*—and gets an infinitesimal portion of the lot as prospective customers.

The price per page, one time, for general magazines runs from $100 to $4000.

Now, here are some census figures that will show you, who are interested from the *reader's* point of view, how little chance a *general* advertiser making, say, clothing, has in a *general* magazine.

Then you can figure how little chance a *machinery* advertiser has in general papers.

All men wear clothes—only a slight proportion of them buy machinery.

Assume that this clothing maker's product sells for an average of $30 per suit.

Fifty-two per cent. of the people live in the country; $10\frac{2}{3}$ per cent. in semi-urban and $37\frac{1}{3}$ per cent. live in cities and towns.

An average family consists of five persons.

Nearly 33 *per cent.* of these families have an average income of less than $400 per year or about $80 per capita.

Not many $30 suits to be sold there.

About 21 per cent. of these families have an annual income of $400 to $600.

Some 15 per cent. have an annual income of $600 to $900.

Only $10\frac{1}{2}$ per cent. of them have an annual income of $900 to $1200.

Only $7\frac{1}{2}$ per cent. of them have an annual income of $1800 to $3000. An average per member of the family of $360 to $600. (Now you're in the thirty-dollar-suit class.)

And only 5 per cent. have over $3000. (They are out of the "ready-made" class into made-to-order clothing.)

Some problem to advertise profitably, isn't it?

If your article is for men only or women only, your public is halved.

There are 9,000,000 negroes—10 per cent. of the population is black.

If your general magazine is a low-priced one catering to the popular idea of easy fiction, a-b-c politics, and how-to-live-on-30-cents-a-day, the circulation strikes an average of the country's population.

How many machinery buyers are there among them all?

Now witness why Engineering News and other good technical papers can *profitably* advertise machinery and allied things.

The editorial contents of this paper automatically limits the readers of it to men actually interested in civil engineering and contracting.

Those men represent concerns which have the money to buy that machinery which will enable them to make more money!

The circulation instead of being hundreds of thousands is 21,000.

That means a rate in proportion.

The advertiser of concrete machinery, for instance, who spends $4,000 for a single page once in a general medium can buy more than a page in *every* issue of Engineering News for 52 weeks.

Instead of making the here-today-gone-tomorrow impression, he gets the powerful, cumulative effect of week after week advertising.

Verily, the machinery man who listeth to the lure of the general magazine is putting his shekels where they do him the least good.

It's great to be able to show the family your ad. in "Munbody's;" it's a heap of satisfaction to show the barber, the butcher and the landlord—but, bless you, it doesn't bring home the bacon.

Get this point:

The general magazine will take any decent ad.—barring medical, cigarette and liquor stuff—whether for baby's food or hack-saws. This paper won't take anything that isn't by way of being intended for use in the field it aims to cover editorially.

That is another reason why you can read the Selling Section through with no danger of wasting your time—with full assurance of finding help in your *business*.

Engineering News

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The South Eighth Street Viaduct, Allentown, Penn.

One of the most notable of the many large reinforced-concrete viaducts which are now being erected in this country is the South Eighth St. viaduct, which crosses the valley of the Little Lehigh River between the main portion of the city of Allentown, Penn., and the 12th ward, formerly known as South Allentown. A bridge at this location was projected as early as 1900, and in 1901 the foundations for a steel viaduct were laid and the contract let for the fabrication of the steelwork itself. Financial difficulties set in soon after, however, and the work was never continued. In 1911 the Allentown Bridge Co. was organized to take over the property of the old Allentown and South Allentown Bridge Co., which had projected the earlier bridge and in connection with the Lehigh Valley Transit Co., an interurban line running between Allentown and Philadelphia, financed the present viaduct. This new structure is to carry the heavy interurban trains of the transit company and is to provide also a highway toll crossing. The erection of so large a bridge as a commercial undertaking is out of the ordinary at this time.

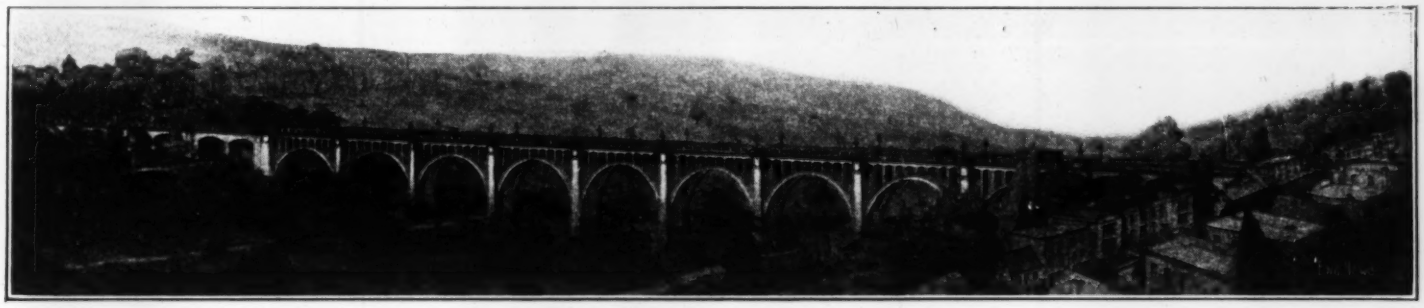

FIG. 1. REINFORCED-CONCRETE VIADUCT ACROSS VALLEY OF LITTLE LEHIGH RIVER, ALLENTOWN, PENN.
[From architect's perspective.]

The viaduct connects South Eighth St. in Allentown to South Ninth St. in South Allentown, and deviates only slightly from a straight line connecting the termini of these streets at the valley. It crosses a valley about 125 ft. deep at its deepest part, through which runs the small stream known as Little Lehigh River, and the tracks of two railroads, as well as a number of city streets.

The viaduct, inclusive of approaches, is 2600 ft. long, the main part of which is made up of nine 120-ft. clear span arches and eight 52½-ft. girder spans arched for architectural effect. It carries a 32-ft. roadway, with two 7-ft. sidewalks, on a negative 8% grade which eases off into a positive 2.6% grade at the south approach.

MAIN ARCHES—The main arch spans are made up of two approximately semicircular arch ribs, spaced 26 ft. on center, 8 ft. wide, 4 ft. deep at the crown section, and about 11 ft. deep at the springing line. These ribs are each surmounted by spandrel walls extending over their full width and carrying longitudinal spandrel arches, and transverse semicircular arches upon which the floor slab rests. These transverse arches and the floor slab itself furnish the necessary bracing to the arch ribs. The sidewalk slabs overhang the parapet walls 5 ft. The details of one of the large arches are shown in Fig. 2, and a view underneath the arch in Fig. 5.

GIRDER SPANS—The short spans are 52½ ft. between faces of abutments, and consist each of four longitudinal reinforced-concrete girders in arched form. The details of the design are shown in Fig. 2. The main point of interest is that the floor slab was designed as a part of the compression flange making up the T-section, of which the girders form the web. Over these smaller arches, the sidewalk and balustrade overhang only 2 ft.

PIERS—The piers supporting the main arches are formed of two separate monoliths, one to each arch rib. These piers extend to bedrock and rise as single solid pedestals to the arch skewback, above which elevation a pilaster of hollow construction with 2-ft. walls is built to support the spandrel arches. The piers are spaced 18 ft. apart transversely for the 120-ft. span (Figs. 3 and 6).

The piers and abutments supporting the 52½-ft. girder span are of cellular construction, having 3-ft. walls in the longitudinal direction carried down to rock, and connected in pairs transversely by curtain walls 1½ ft. in thickness, extending just below the ground line so that they may brace properly the slender piers and add to the massive appearance of the combination. The smaller piers are braced by transverse arches in the same manner as the larger piers.

This arrangement of separate pedestals for each rib of the arches leaves a longitudinal opening on the line of the bridge, so that the view from either end is that of a long arcade. This general impression is shown well in Fig. 5. The old piers which were placed for the 1901 bridge were not utilized in the construction, but the abutments which were then built of stone masonry were utilized for a portion of the extreme abutments to the new bridge.

EXPANSION—The short spans are arranged in groups of two, separated by a wide pier on both sides of which expansion joints are placed. In the large spans, alter-

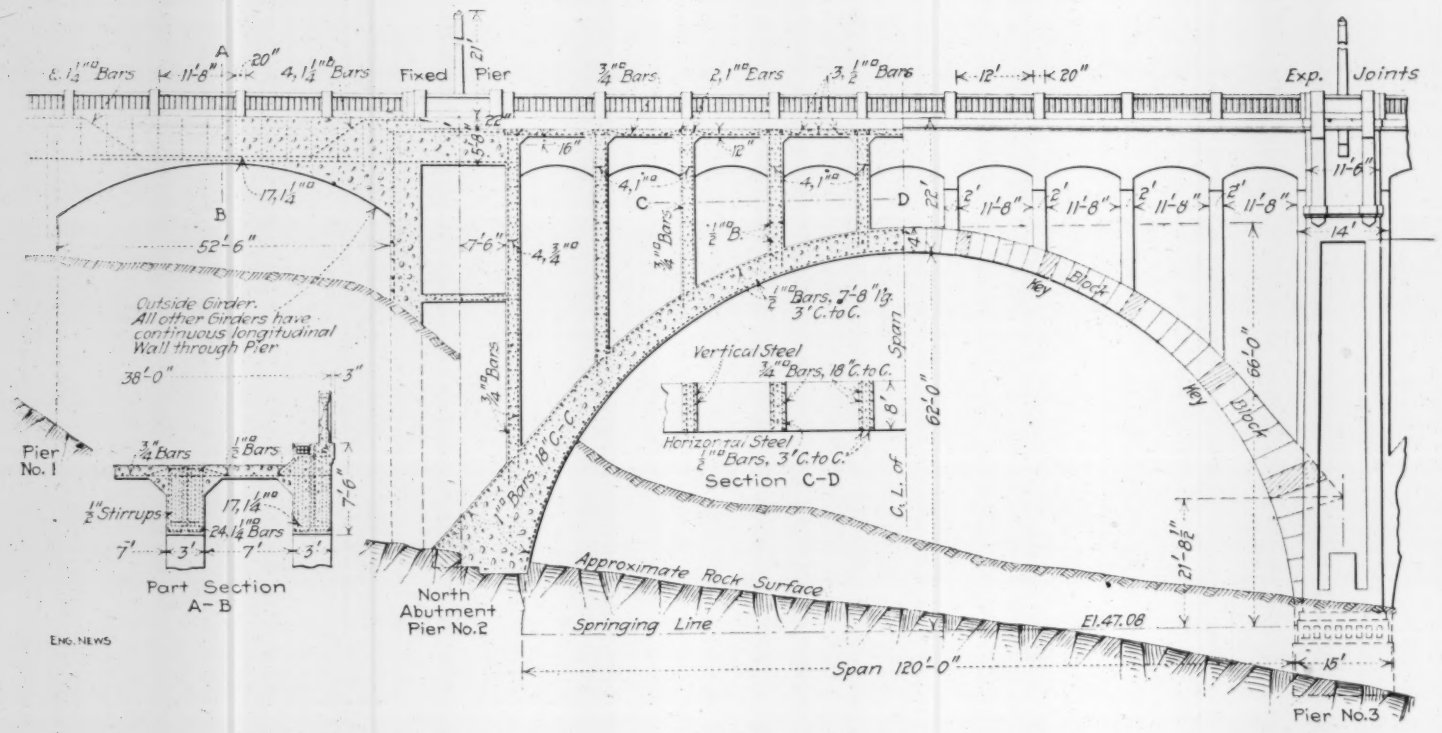

FIG. 2. DETAILS OF A 52½-FT. GIRDER SPAN AND A 20-FT. ARCH

nate piers are made expansion and fixed with somewhat different construction in the floor slabs, and in the upper parts of the pier.

At the expansion piers the floor slab across the pier is lowered so that the slab on the adjoining arch may slide upon it and small I-beams or old rails are placed at the upper portion of the pier slab and the lower portion of the span slab to form a grillage upon which the two slabs may slide.

In Fig. 3 sections through a fixed and an expansion pier are shown, and the difference in construction of the two piers made clear. It may be noted that the longitudinal spandrel arches are included in the expansion joint, and that they rest on a bench cut out of the main vertical wall of the pilaster of the pier.

ROADWAY—The roadway of the bridge is to be of vitrified brick laid on the regulation sand cushion and concrete base which is to be placed (Fig. 3) on a broken stone fill. The whole roadway is to be carried on the flat reinforced-concrete slab noted above. The street car tracks are to be laid on the ballast. The roadway is to be waterproofed with a patented waterproofing felt, according to the following specifications:

> The waterproofing shall consist of four layers of felt applied as follows:
>
> (1) A coating of asphalt compound of not less than 5 gal. to the square.
>
> (2) Four layers of felt, or their equal, weighing not less than 14 lb. per square, placed on the compound while hot and each layer mopped with compound when laid.
>
> (3) A final coating of hot compound protected by 2 in. of concrete.

The railings, balustrades and trolley and light posts are to be ornamental concrete, with a bush-hammered surface and with bronze fittings.

Under the sidewalk the proper conduits for wires and pipes are provided.

LOADS—W. J. Watson's "Specifications for Class E Bridges" were followed both as to assumed loading and allowable working stresses in steel and concrete.

CONSTRUCTION

At the beginning of the work a low heavy trestle was laid along the center line of the bridge for the distance covered by the 120-ft. arches. On this trestle a track was laid upon which were run two heavy lo-

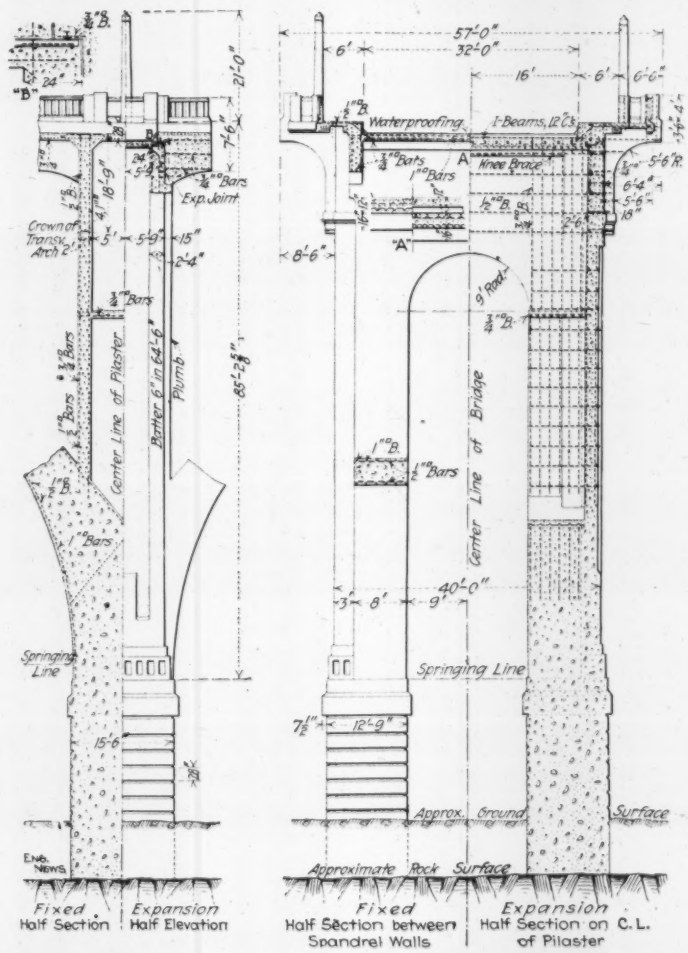

FIG. 3. CROSS-SECTION THROUGH SOUTH EIGHTH ST. VIADUCT, SHOWING PIER AND ROADWAY DETAILS

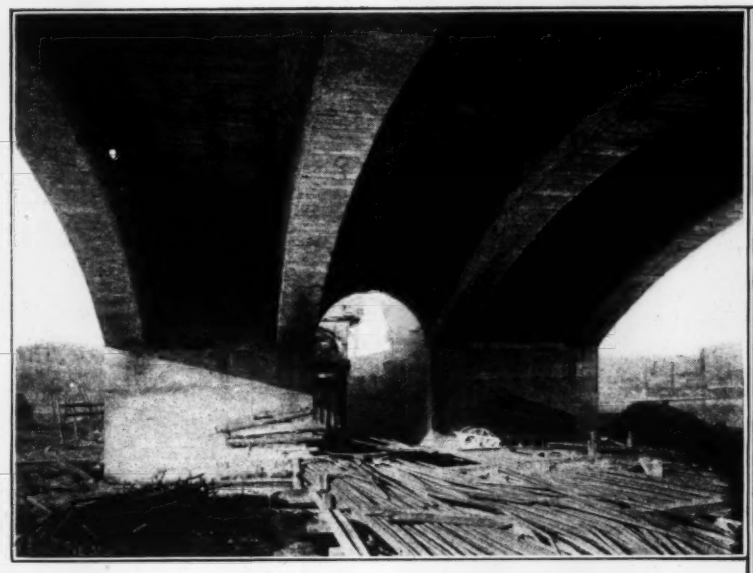

FIG. 4. UNDER SIDE OF A GIRDER SPAN

comotive cranes. These cranes were used for all the work in constructing the piers up to a point about 25 ft. above springing line. They are used in excavating the pier sections, in building the monolithic section of the pier, and on account of their extreme strength and boom length were also used in the higher part of the pier work. One of these cranes at work is shown in Fig. 6.

To the east of the bridge there was erected at the same time a light trestle, shown also in Fig. 6, upon which run flat cars drawn by locomotives, which trains were used in bringing concrete and lumber to the piers and in removing all excavated material.

The concrete for the middle or main section of the bridge was mixed at a large central mixing plant located about the middle of the bridge, and equipped with a 2-cu.yd. mixer. All material was brought in by rail on a spur track from the main-line railroad which runs down the valley.

A clam-shell bucket, operated by a large stiff-leg derrick, unloaded the sand and broken stone from the cars into storage piles and was used to elevate these materials into the bins above the mixer. The cement was conveyed from the cement house to the elevated mining platform by means of a belt conveyor.

After the piers were completed to the point shown in Fig. 6, large 80-ft. derricks were mounted on steel towers resting on timbers spanning the opening between the two sections of each pier, Fig. 8, and the further work of construction, including a large part of the floor slab, was carried on by means of these derricks taking material from the light trestle along the east side of the bridge.

The final operation in the erection of the main spans was carried on by a traveling derrick moving along the completed portion of the floor system.

At the same time work was going on at the large arches, the construction of the piers of the approaches was being carried on by hand labor, assisted by portable mixers, which could be moved from one part of the work to another. At the south approach a wooden tower elevator, shown on the extreme right of Fig. 8, was erected to elevate the concrete to the floor level of the approach.

CENTERING—For the nine 120-ft. arches three full sets of steel arch centers were used, using each set for three of the arches.

FIG. 5. LOOKING UNDER AN ARCH SPAN

Each set of centers consisted of two independent-trussed arches of the outlines shown in Fig. 7, each arch supporting one of the twin concrete arch ribs and being itself made up of two steel arch ribs interbraced with steel struts. Across the upper chords of these steel ribs, which were curved to the curve of the concrete arch, was

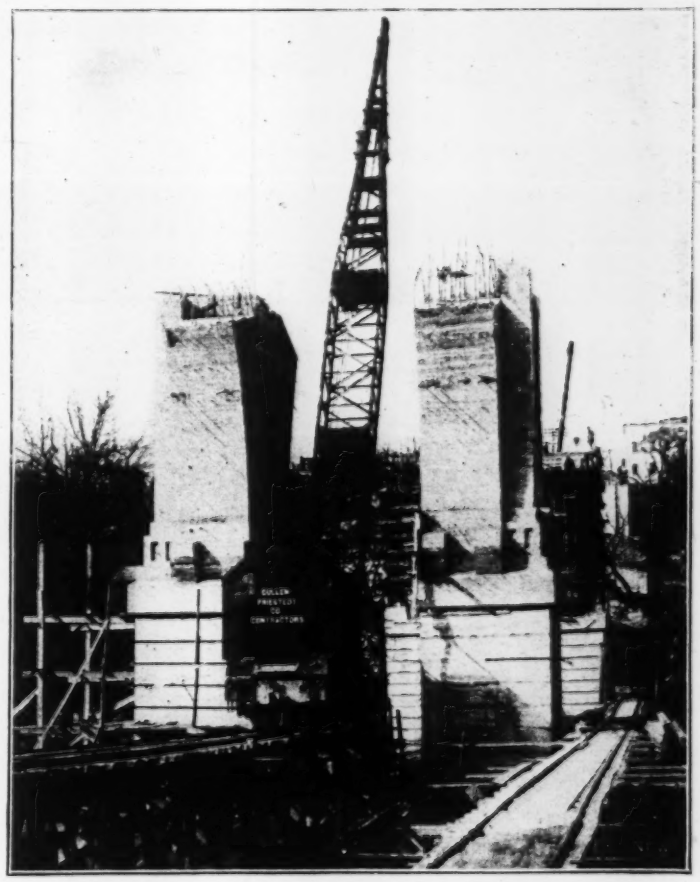

FIG. 6. PIER UNDER CONSTRUCTION, SHOWING TWO LINES OF CONSTRUCTION TRACKS

bolted the wooden lagging on which the concrete was deposited. The twin centering arches were held together by a timber cross-beam and diagonal steel rods.

The arch trusses were fabricated in six sections and riveted on the ground into semi-arches, which were lifted by derricks into place, to be bolted at the base to the supporting columns. At the crown it was riveted solidly in the bottom chord, but bolted through slotted holes at the upper chord, to insure the stress passing through the lower chord.

The centers were supported on inclined steel columns (Fig. 7) which footed on concrete steps purposely projected from the main section of the pier, and cut off after the centers were struck. The base plates of the columns rest on cast-iron wedges which in turn rest on I-beam grillages footing on the aforementioned concrete projection. Between the column base and the projection, 10-ton screw jacks are interposed to aid in the alignment and leveling of the centers; they are allowed to remain in place, though the load passes directly to the wedges, which are used for striking centers. A U-shaped clamp, made of a 1-in. bolt (not shown in the drawing), is passed around each pair of wedges to prevent any possible lateral motion. A similar bolt is used for the same purpose higher up on the main column.

The 52½-ft. spans were built on wooden centers of the usual design. Four sets were provided, each set being used twice.

CONCRETING—For the large arch spans the concrete was laid in alternate voussoirs of wide blocks and small keys in the order shown in Fig. 2. The large voussoir blocks were placed in pairs symmetrically distributed over the steel centering so that uniform loading might be carried down to the piers. All blocks were allowed to set seven days before the keys were poured. The work was carried on over three arches simultaneously, thus utilizing the three steel centers as described above. In order to care for any unbalanced stresses which might

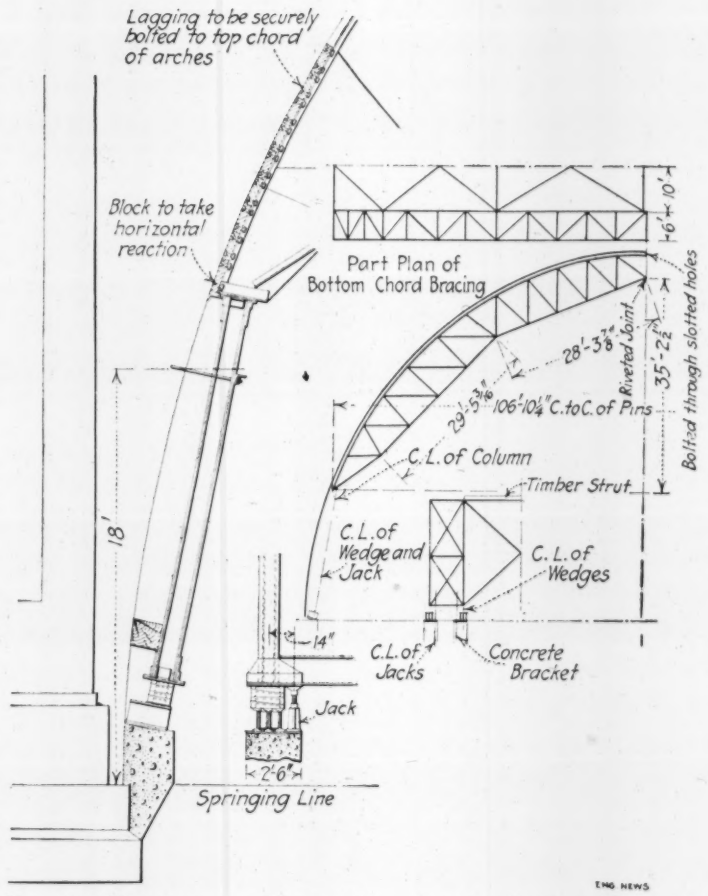

FIG. 7. DETAILS OF STEEL CENTERING, SOUTH EIGHTH ST. VIADUCT, ALLENTOWN, PENN.

(Designed and fabricated by the Blaw Steel Construction Co.)

come to the piers the third, sixth and ninth piers were each enlarged slightly at their footing, so that the unbalanced load would not affect their stability.

The centers for the large arches were struck 28 days after concreting the key sections. No appreciable deflection was noted in any of the spans. After the arch centers had been struck and the forms removed to the next

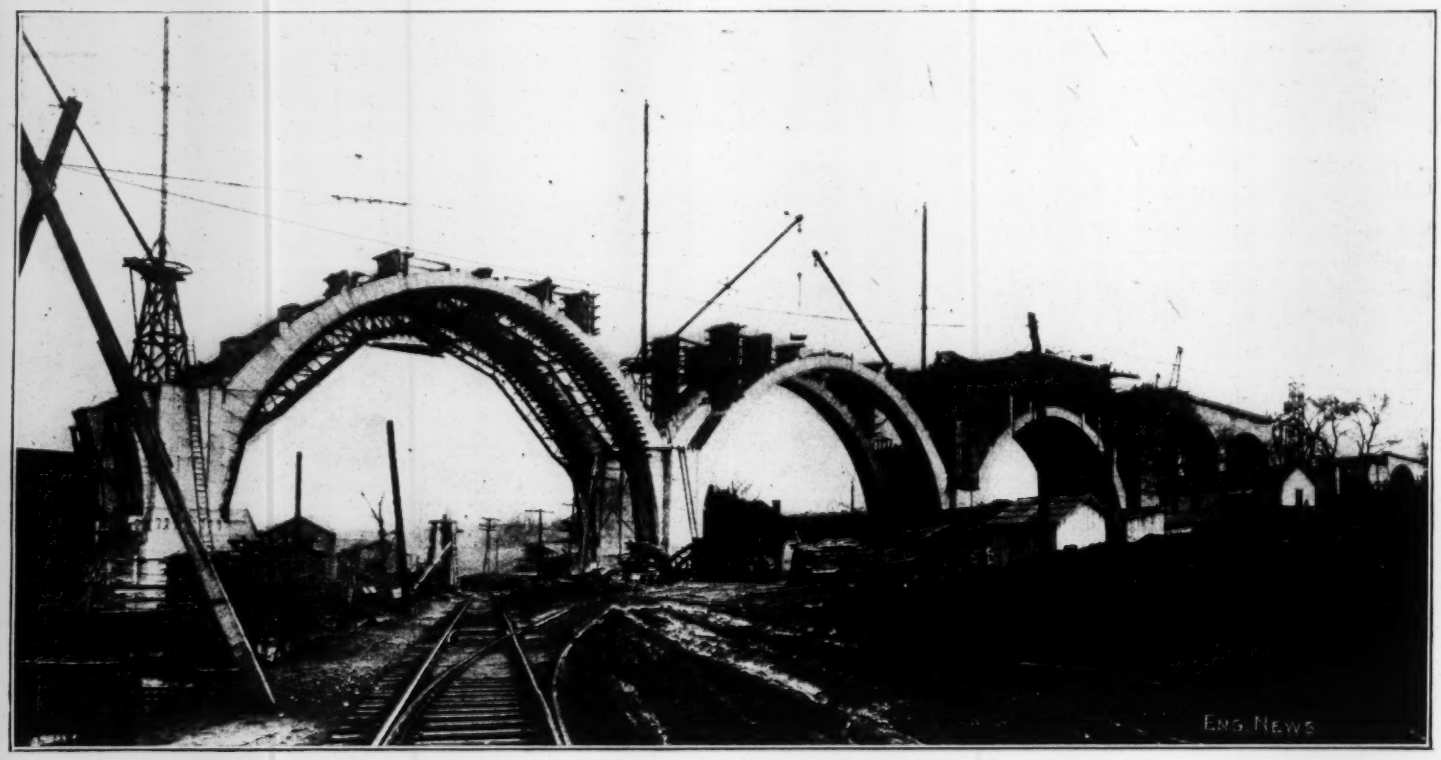

FIG. 8. VIEW OF ALLENTOWN VIADUCT UNDER CONSTRUCTION

set of arches, construction was started on the spandrel walls of the arches already completed.

In the smaller spans the girders were concreted as a monolith and continued over one intermediate pier. This at times required night work.

MATERIALS—All the reinforced-concrete slabs, girders and main arch rings were made of 1:2:4 concrete, the broken stone passing a 1-in. ring. The remaining part of the work was made of a 1:3:5 concrete, made up of crushed rock, sand and broken stone passing a 2½-in. ring. The use of rubble concrete was permitted in the large masses of the main piers, but the contractors did not avail themselves of this privilege except in a very few instances. All reinforcement was made up of square corrugated bars.

SURFACE FINISH—A smooth troweled finish was given to all sidewalk areas. The main portion of the bridge is to receive a carborundum rubbed finish, and the balustrades, posts, railings, lamp-posts and trolley poles are to be made of a special granolithic concrete, which is to be bush-hammered or tool dressed.

PERSONNEL—W. W. Wysor, Chief Engineer of the Allentown Bridge Co. and of the Lehigh Valley Transit Co. is in charge of the construction of the viaduct, B. H. Davis, Consulting Engineer, New York City, prepared the plans and specifications for the structure and is acting as consulting engineer during its construction. The contract was let to the McArthur Bros. Co. of New York for $306,000, exclusive of the cement, which is furnished by the owners. About 40,000 barrels of cement is expected to be used on the contract. The contractors are represented in the field by F. C. Cullen of the contracting firm of Cullen & Freistedt, of Chicago. The steel centers were designed and fabricated by the Blaw Steel Construction Co., of Pittsburgh, Penn.

Construction was begun July 1, 1912, and the contract calls for the completion of the viaduct by Nov. 1, 1913, but present progress seems to promise an earlier opening.

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A Novel Plan of Collecting Fine Dust from a Copper Reduction Plant

In the Feb. 13 "Bulletin of the Institution of Mining and Metallurgy," there is published a series of interesting papers (the first of them by Dr. Jas. Douglas of Phelps, Dodge & Co., New York City) describing the conditions and methods of work employed at the Copper Queen mines in Arizona. Among other features, there is described a mechanical difficulty which was encountered in the reduction process at the Douglas (Ariz.) plant, and methods of overcoming it.

The smelting operations at this location have been carried on exclusively in blast furnaces, and the charge has been difficult to treat because of extreme fineness, the disintegration of pyrites and clay ores and of the fine concentrates, making great quantities of dust. The metal loss from the escape of this dust with the smoke and flue gases was discovered through the fact that the metal loss in the slag by analysis failed to cover by an appreciable amount the known total loss as determined by ore analyses.

To investigate the amount of metal loss in the smoke, an 8-in. pipe was run to the top of the stack, then over and down a short distance, and arrangement was made for the placing of the inlet at any point from the center to the side. The lower end of this pipe was connected to the intake of an exhaust blower, discharging through woolen bags. The fan speed was so regulated that the velocity of gases at the inlet to the pipe was the same as the velocity in the stack.

At first the amount of dust collected was small because the cloth was not of fine enough weave, but using very finely woven material a surprising amount of dust was recovered. It was later determined that 90% of this dust would pass a 200-mesh screen. Repeated experiments were made varying the conditions of draft, and of the number of furnaces in operation and it was found that between 0.06 and 0.16% by weight of the smoke consisted of dust, which contained approximately 9% copper, 8% lead and 5% zinc. The next problem was to devise a practical way to settle this dust on a commercial scale.

The method of bag filtration was eliminated from consideration because of the weakness of the fabric and of the quantity of smoke to be handled, over 1,000,000 cu. ft. per min. The experiment was then tried of passing the smoke at low velocities through a chamber of large cross-section, and it was found that, at velocities of 150 ft. per min. or less, the very fine dust would settle in comparatively short distances, and also that with transverse wire screens at 3 ft. intervals equally good results were obtained at twice that velocity, so that the cross-section of the chamber could be reduced.

Similar experiments to the above were conducted on the converted smoke. From 0.015 to 0.035% by weight of this smoke was found to consist of dust, containing about 4.5% copper, 16% lead, and 10% zinc.

The dust chamber mentioned above was designed with a steel frame and with floor, walls and ceiling of hollow tile. The wire screens were so placed that there were at least 10 obstructions to any passage through the chamber. No exact data are yet available as to the efficiency of this method of removing dust from the flue gases, but it is known that the greater proportion of the dust is removed.

Having removed the dust, in large measure, the next difficulty was to provide a way to get this dust in such shape that it could be handled and treated in the furnace. After extended experiments, a device was hit upon for mixing the dust with molten converter slag. A mixing tank of sheet-steel, with a cast-iron lining, and in shape a truncated cone with axis horizontal, is supported on riding-rings which turn on rollers with a movement similar to that of a barrel type converter. This mixer is turned by a chain and sprocket secured to the outside of the drum. The molten converter slag, poured from a ladle, and the flue dust, delivered by a pipe from the storage tank, are fed together into the small end of the cone, which revolves about five times a minute. By this action the slag and dust are rolled together making a porous, lumpy mixture admirably suited to blast furnace work. Control of the rates of flow of slag and dust and of the speed of the drum are brought to one position facing the large end of the cone. In this way one man is able to handle the mixing process. The proportions of slag and dust and the drum speed are determined by the operator's judgment as to the character of the finished mixture, which is in plain sight from the control position.

The 40,000,000-Gal. Direct-Acting Explosion Pumps at Chingford, England*

At the time H. A. Humphrey described his design of direct-acting internal-combustion pumps before the British Institution of Mechanical Engineers (see ENG. NEWS, Dec. 2, 1909) the Metropolitan Water Board (for the London district) was building a large reservoir at Chingford, where some 180,000,000 gal. a day were to be raised 25 to 30 ft. from the River Lea. On account of drainage works in the upper valley, the floods are now higher than before and of shorter duration; therefore, to impound the desired proportion of the waters, powerful pumping equipment is necessary. The Board had expected to use centrifugal pumps on account of low first cost and in spite of their low efficiency. The invention of Mr. Humphrey proved attractive to the Board on account of the very low first cost and high efficiency (Prof. Unwin had reported a record of 1.06 lb. coal per pump horsepower-hour). Tenders were invited for these explosion pumps in competition with centrifugal apparatus and, when opened, it was found that the cost for four 40,000,000-gal. and one 20,000,000-gal. pumps together with the gas producers, etc., was $95,000 less than for triple-expansion steam-engine centrifugal pumps. The fuel consumption was guaranteed to be not over 1.1

*In part from London "Engineering," Feb. 14, and the "Engineer," Mar. 14, 1913.

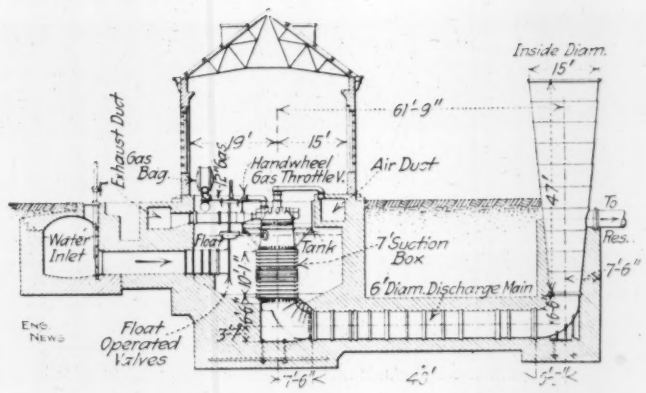
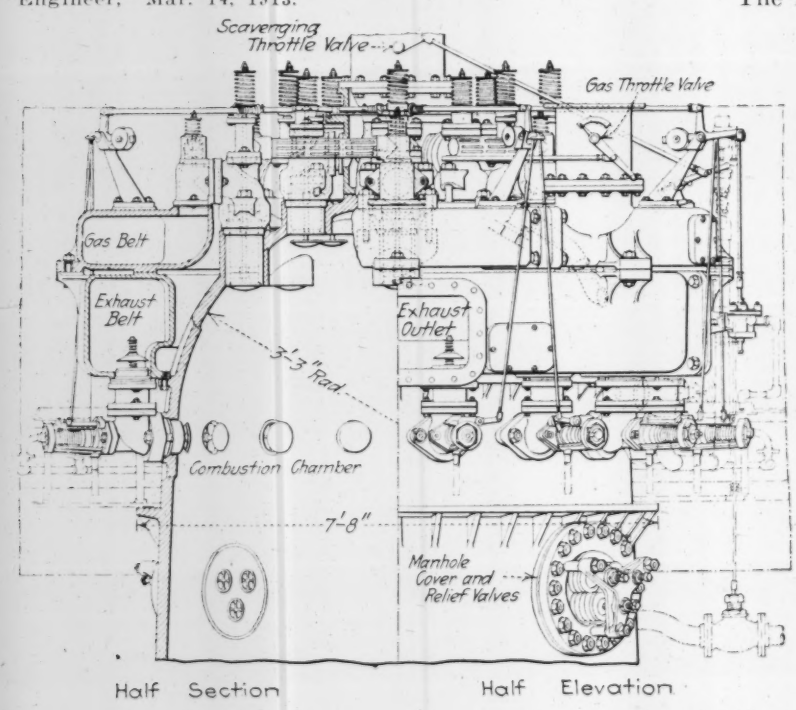
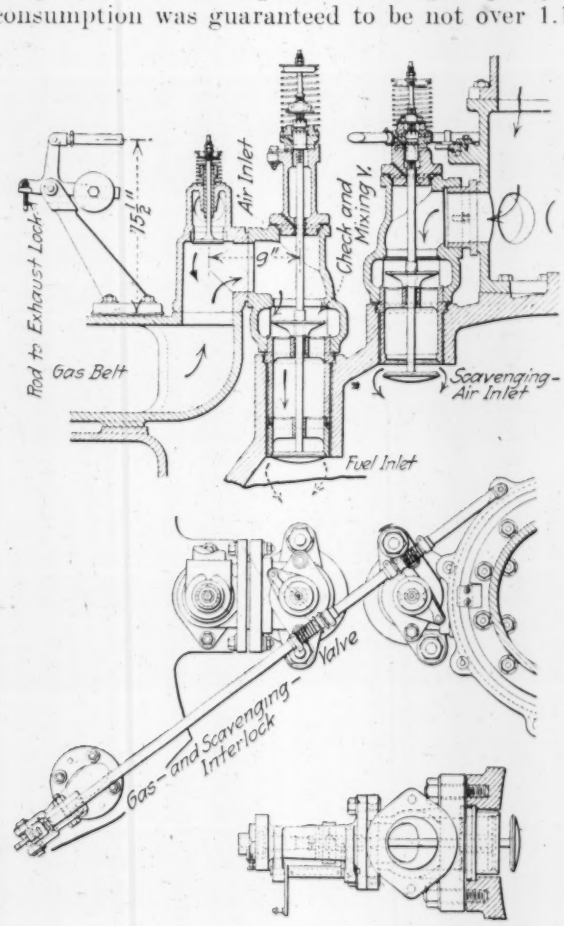
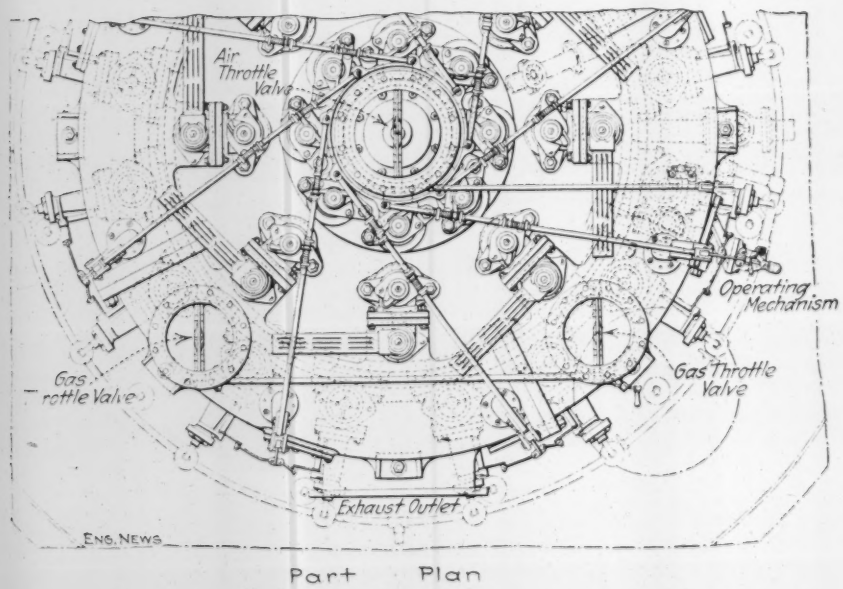


FIG. 1. CROSS-SECTION OF CHINGFORD PUMP HOUSE, SHOWING HUMPHREY EXPLOSION PUMP







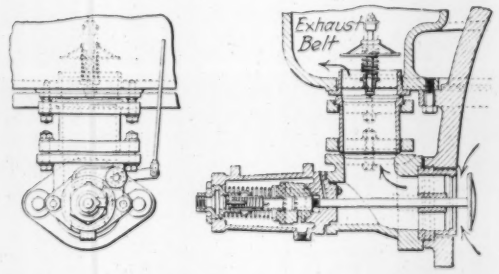


FIG. 2. COMBUSTION CHAMBER AND VALVE DETAILS. HUMPHREY PUMPS AT CHINGFORD STATION

lb. of anthracite per pump horsepower-hour (in gas producers) with a penalty of $5000 for each $\frac{1}{10}$ lb. in excess of that rate. The fuel consumption for the steam plant was estimated at from two to three times that. A penalty of $100,000 was also accepted for failure to provide a successful plant. The pump horsepower is about 250 for a large unit and 125 for the small one. Each is reported designed for about 25% overload capacity.

It will be recalled that this type of pump consists essentially of a U-tube with legs of unequal length. The short leg is connected near the bottom, to the source of supply and the long leg some ways above the bottom, to the higher reservoir. The closed top of the short leg forms the explosion chamber and has air- and gas-inlet valves and a scavenging valve. Admission check valves for the water are provided in this leg below the natural-supply level. A charge of gas and air trapped above the water in the short leg is ignited by an electric spark and this sets the water column in motion. The momentum of the column causes the water to flow until the pressure in the combustion chamber is reduced to atmospheric or lower, when the exhaust and scavenging valves and the water-inlet valves open. The lower part of the leg fills up with water and a pocket of pure air fills the top (above the spent gases). The water remaining in the high leg soon forces the U-column backward, expelling the spent gases through the exhaust valves which are then closed and locked so that the air in the top is compressed. On the following forward surge of the water column, the air and gas inlet valves open admitting a new charge of fuel. The water surges back the second time, compressing the charge and this completes the cycle of operations as the new charge is ignited.

The Chingford pumps differ from the early types by having in place of the large single admission, scavenging and exhaust valves, a number of small ones. A section through the explosion chamber of one of the 40,000,000-pumps is shown in Fig. 2. The chamber is surrounded with a gas-belt casting and, below this, an exhaust-belt.

The 8 inlet and 16 exhaust valves open communication with the gas and exhaust pipes respectively. An air inlet valve fitted with a silencer is fixed to the passage between the gas-belt and the fuel inlet valve of the chamber; a check valve serves to complete the mixing and prevents the backward passage of spent gases under explosion pressure. The eight scavenging valves are connected to a central air box on the top of the chamber, and this is connected to an air duct (Fig. 1) which may be kept under a pressure of ¾ to 1½ lb. per sq.in. if overload capacity is needed (permitting use of a richer mixture).

The scavenger and gas valves are interlocked by catches and rods (Fig. 2). These eight rods are coupled to an oscillating ring which is moved by a relay connected to the water in the pump chamber. At the pressure rise due to the first return of the water column, the relay shifts the ring and moves the rods in the direction shown by the arrow in Fig 2, locking the scavenger valve by moving in an attached lever but unlocking the gas valve by moving out its attached lever; by a 90° bell crank and rod attachment the exhaust valve is also latched. On the second forward surge of a cycle, then, only the gas inlet can open. On the return surge (compressing the charge) the relay shifts the ring and rods to lock the gas inlet and to unlock the scavenger and exhaust valves so that they may open after the initial surge of the column.

The springs of the exhaust valve are adjusted so as to tend to hold it open while the springs on the scavenging valves would hold them closed. To prevent drawing back spent gases on the scavenging surge, a light check is fitted between the exhaust valve and the belt casting. To prevent hammering of the exhaust valves, the tail ends of the valve spindles project into dashpots. Water enters these chambers from a low-pressure ring line carried around the explosion head but is shut off by a small poppet on the end of the spindle, when the valve is nearly closed. The water trapped in the dashpot can escape only through a small hole and the seating blow is cushioned.

The ignition system has 16 spark plugs encircling the

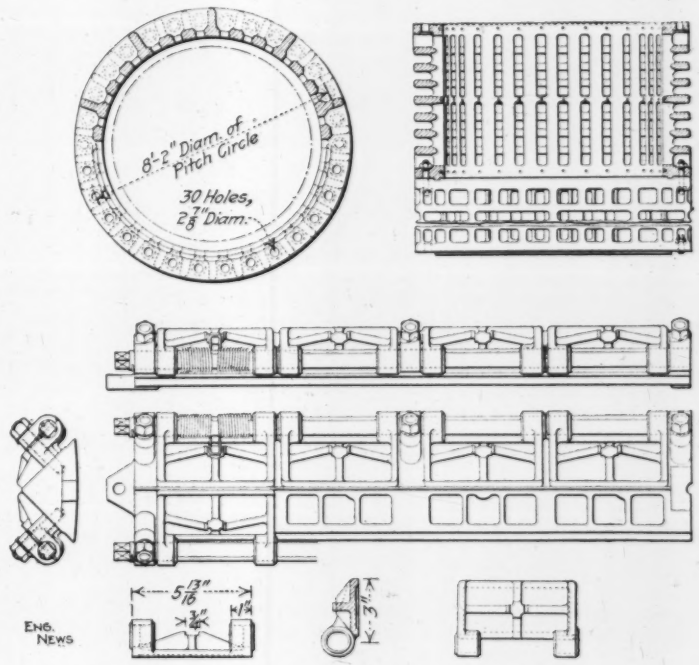


FIG. 3. WATER SUCTION BOX AND VALVES, CHINGFORD PUMPS

dome head of the explosion chamber and these are connected to induction ("trembler") coils. Current is supplied by storage batteries under the control of a make-and-break device operated by the compression stroke of the water column.

As may be seen from Fig. 1, the suction-valve box supports the combustion chamber and is in turn supported on a cast-steel pipe elbow and frame. The suction box is 7 ft. in diameter but the discharge elbow tapers its bore from 7 ft. to 6. Simple vertical flap valves are placed inside the box at the ports. Details of these are shown in Fig. 3. Each box stands submerged in an open pit which communicates with the intake canal by a cast-iron pipe 5 ft. in diameter. Sluice valves shut off each pump pit from the canal and a working platform surrounds each pump head. From a point about 23 ft. above the discharge main, a 4-ft. pipe discharges through the reservoir wall just above water level into baffle chambers in the reservoir.

A continuous stream is delivered from the outlet pipes, due to the steadying effect of the water towers. At first there was some splashing in these water towers but this was stilled by floating a wooden raft in each.

The first large unit was started up slowly but the sec-

ond was brought from cold condition to full load in 4½ min. after the initial explosion; the third unit was started in 3 min. and the last two in 2 min. This is claimed to be a record for first starts in power apparatus. At starting, the combustion chamber and play pipe are full of water up to the level of the penstock chamber; a mixture of gas and air is pumped into the explosion head and fired by hand closing of the ignition circuit. The resulting impulse sets up sufficient movement of the water column so that the pump drops into normal operation and soon assumes its regular period (nine cycles per second in this case).

The pumps have not yet been tested but it is reported that there is "ocular demonstration" that the pumps exceed the contract requirements as to capacity.

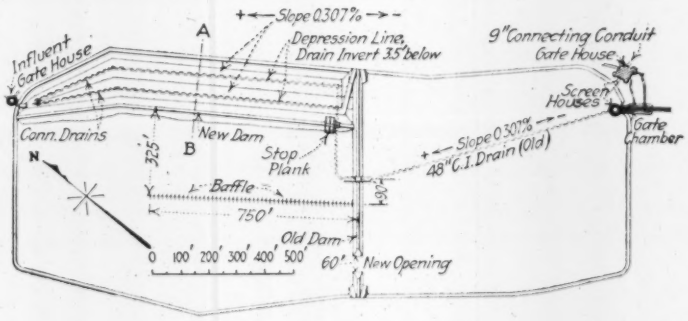
The designs shown above were made by the Pump & Power Co., of London, under direction of H. A. Humphrey; the units were built by Siemens Bros. Dynamo Works. Much credit is being given locally to W. B. Bryan, Chief Engineer of the Metropolitan Water Board for his initiative in this notable application of a novel form of prime mover.

New Sedimentation Basin in Georgetown Reservoir, District of Columbia Water-Supply

The water-supply for the District of Columbia is taken from the Potomac River at Great Falls, about 18 miles above the center of the city, and passes through a conduit to its first storage at the Dalecarlia Reservoir, about 5 miles north of the city. After passing through this reservoir it goes into the Georgetown Reservoir just north of Georgetown, from which place it is taken by pipe line under the city to the new filtration plant just to the northeast of the city limits. The Potomac River water is very apt to be quite muddy, so muddy, in fact, that the ordinary processes of the slow sand filters will not remove the sediment. On this account in 1910 money was appropriated to construct a coagulating plant located between the Dalecarlia and the Georgetown reservoirs. As an adjunct to this plant it became necessary to provide in the Georgetown Reservoir a sedimentation basin, in which the coagulent could do its work. This reconstruction of the Georgetown Reservoir is described in the March-April number of *Professional Memoirs, Corps of Engineers and Engineering Department at Large*, in an article by Lieut. J. J. Bain, Corps of Engineers, U. S. A. From that article we have made the following abstract:

The Georgetown Reservoir is in shape almost a rectangle approximately 2250 ft. long and 850 ft. wide. Its area is about 42 acres. As originally designed, the reservoir was to have been divided into two sections, the upper containing about 24 acres and the lower about 18 acres. This provision was to have been made by an embankment, the top of which was to be at an elevation 2 ft. lower than the ordinary surface of water in the reservoir. According to this design, the upper section would have become a sedimentation basin and the lower section a storage basin where the pure surface water, flowing in a thin stream over the top of the dividing embankment, would be stored until drawn off from the opposite end of the lower section for consumption. As built, however, the dividing bank of the reservoir was made to the full height of the outside bank and a narrow cut lined with masonry and fitted with stop-plank openings was left in the middle of its length. Through this cut a 48-in. cast-iron pipe line was laid beneath the bottom of the lower section to the effluent gate-house. According to this arrangement, water could be drawn from the lower section after having passed through both sections, or it could be drawn direct from the upper section through the cast-iron pipe without passing through the lower section.

This arrangement served admirably for a number of years, but as the consumption of water in the city increased, the draft through the middle opening of the dividing embankment became so great that the greater part of the water which reached the city's mains was drawn in a comparatively narrow stream straight from the upper influent to the middle gate and then straight to



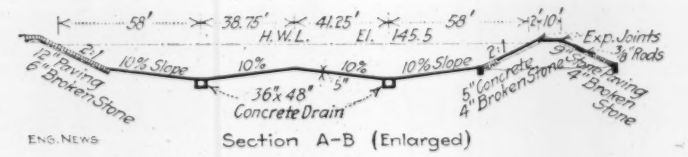


FIG. 1. PLAN OF REBUILT GEORGETOWN RESERVOIR, WASHINGTON, D. C., AND SECTION THROUGH SEDIMENTATION BASIN

the effuent gate. In times of turbidity the muddy water followed this stream and did not diffuse itself through the whole body of water in the reservoir as it should have done in order to produce the greatest amount of settling.

In the appropriation bills of 1912 and 1913, Congress provided $108,000 to be devoted to the reconstruction of the Georgetown Reservoir to provide sedimentation for the coagulated water. This appropriation is now being expended on the work, which, it is expected, will be completed by June next.

The approved project for the expenditure of the above appropriation requires in general the following changes to be made in the old reservoir (Fig. 1): (1) Stopping up the old opening or cut in the middle of the cross dam; (2) cutting a new opening near the extreme southern or right-hand end of this cross dam; (3) erection of an earthen dam at the northeast portion of the upper section, starting from the upper end of the reservoir near the influent gate and running in a general way parallel to the northeast side of the reservoir until it intersects the cross dam; (4) the construction of a gap or cut in the lower end of the new dam, containing eight sluice gate openings; (5) paving the top and sides of the new earthen dam with concrete or riprap; (6) the construc-

tion of two longitudinal concrete drains from the inlet to the outlet of the sedimentation basin; (7) paving of the sedimentation basin with concrete; (8) the construction of a reinforced-concrete baffle wall parallel to the new dam in the portion of the upper section outside of the new sedimentation basin, and (9) laying a new section of 48-in. cast-iron drain pipe to connect that already

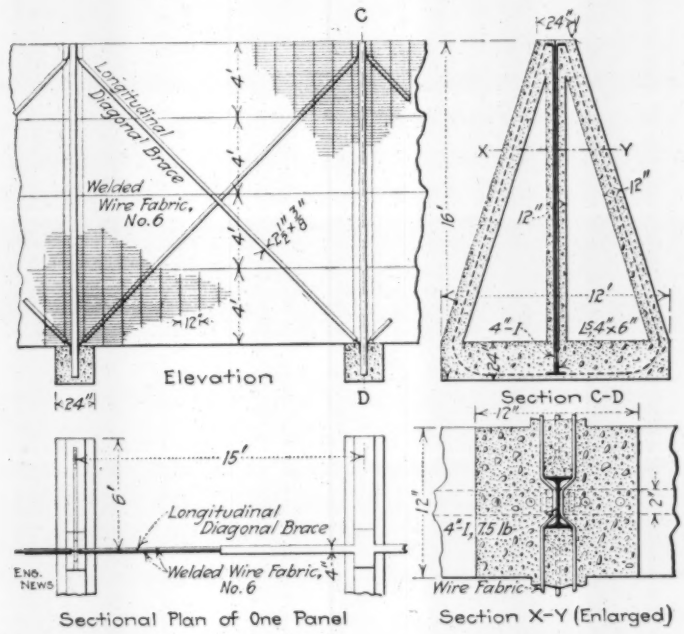


FIG. 2. DETAILS OF BAFFLE WALL

laid with the lower end of the concrete drain in the sedimentation basin.

The details of the new construction are shown in the plan and section in Fig. 1. As will be noted there, the old sidewall of the reservoir is utilized for the sidewall of the new sedimentation basin, but it is paved with 12-in. paving block set on a foundation of 6-in. broken stone. The inside wall of the new sedimentation basin is made of a new earth slope paved on top and sides with concrete resting on the top on the earth and on the sides on a base of broken stone. The basin itself is provided with

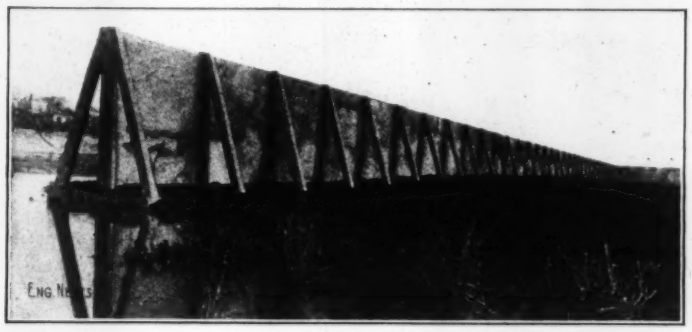


FIG. 3. VIEW OF CONCRETE BAFFLE WALL IN GEORGETOWN RESERVOIR

two gutters formed of concrete box drains with side slopes of 10% leading to them. This whole bottom is paved with a 5-in. concrete flooring.

The baffle wall consists of open reinforced-concrete triangular piers placed 15 ft. apart and connected by a thin concrete web, as shown in the view in Fig. 2. The detail of the construction is shown in Fig. 3. The piers were made by placing the steel reinforcement and concrete in the forms in the usual way and tying the reinforcement of the wall proper to the vertical members of the pier reinforcement. This wall was then made by shooting mortar, with a cement gun, against wooden forming placed behind the outer layer of wire fabric reinforcement until the web had been built up to about 4-in. thickness.

After the above-named changes are made, the coagulated water will enter the sedimentation basin through the influent gate, remain there long enough for the coagulating action to become complete, thus depositing the greater part of the coagulated matter upon the concrete floor of the basin. By means of the sluice gates the water may be drawn into that part of the north half of the reservoir outside of the sedimentation basin, either from near the surface or from near the bottom. Before reaching the effluent gate the water so drawn must travel in a tortuous path around the ends of the new baffle and the end of old cross dam which originally divided the reservoir into two parts. It is believed that by this arrangement the water will be given more time to complete sedimentation and will diffuse itself more thoroughly over the reservoir because, while its velocity is the same as before, it travels over a longer path.

For cleaning purposes, the sluice gates between the sedimentation basin and the remainder of the north basin will be closed and the one in the 48-in. drain opened. Such of the sediment which is not drawn out with the water then in the reservoir will be loosened and carried out by flushing with fire hose. By a new connection at the effluent gate-house the sediment-bearing water will be conducted back to the Potomac by way of an adjacent creek.

This work is under the direction of Lieut. Col. William C. Langfitt, Corps of Engineers, U. S. A., in charge of the Washington Aqueduct, assisted by the author of the paper which we have abstracted, Lieut. J. J. Bain.

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Cobblestone Pavements in Albany, N. Y., have declined from 77.43% of the total in 1885 to 7.99% in 1912, and stone block not granite from 2.6 to 0.81% for the same period. Increased percentages have been: Granite, 17.62 to 33.76, from 1885 to 1912; vitrified blocks, 0.19 in 1894 to 39.32 in 1912; sheet asphalt, 0.81 in 1889 to 10.46 in 1912; macadam, 2.35 in 1885 to 6.73 in 1912. Less than a mile of block asphalt was laid from 1905 to 1912 and 0.07 mile of concrete with a bituminous surface in 1912. The mileage of paved streets of all kinds, based on an average driveway width of 30 ft., increased from 63.6 in 1885 to 95.6 in 1912. The foregoing figures were taken from the report of the Bureau of Engineering of Albany for the year ending Oct. 31, 1912—Frank R. Lanagan, City Engineer.

Supplying Untreated Delaware River Water to Consumers in Burlington, N. J., without notifying the State Board of Health, led the Board to order the Water Commissioners of that city to appear before the Board on on Apr. 8 and show cause why they should not be prosecuted for violating Chap. 317 of the Laws of 1912. The following statement has been received from R. B. Fitz Randolph, chief of the Division of Sewerage and Water-Supplies of the Board:

> This act requires persons in charge of water-purification plants to notify the State Board of Health, and the local board of health in the municipality which the water company serves, within six hours, of any change which is made in the operation of such plant which will tend to impair the quality of the water. The State Board regards this act as of the highest importance and is prepared to insist on strict compliance with its provisions as necessary for the protection of the public health. It appears that, because of a breakdown at the Burlington water-works, raw Delaware River water, which is dangerously polluted at the point from which it is taken by the Burlington water-works, was pumped into the mains and so supplied to the citizens of Burlington for a considerable time on Apr. 1, 1913, without any treatment whatever, and the State Board was not notified of this action until long after the statutory time had elapsed. It is to be hoped that this action on the part of the Board of Water Commissioners will not result seriously, but the use of untreated water from the Delaware River, taken at that point and at this season of the year, is attended by considerable danger.

Slings and Hitches for Handling Machinery*

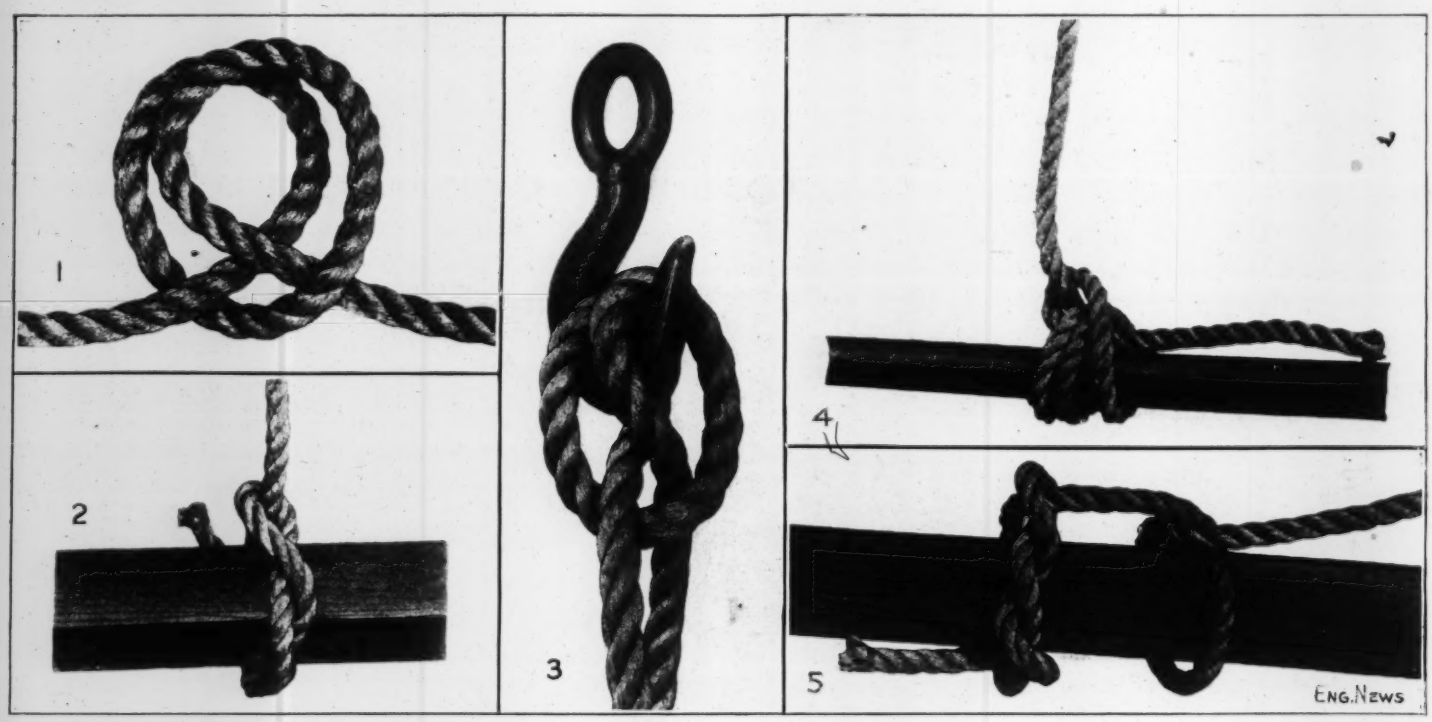
By John Riddell†

The handling of heavy machines and parts of machines in a large electrical factory is, of course, a matter of the greatest importance. The apparatus used includes travelling cranes, jib cranes and other machinery. The weights handled vary between wide limits. The different cranes may vary in capacity from, say, 3 to 100 tons; and the pieces handled may weigh anything from 100 lb. to 100 tons.

Accidents from Cranes—As a general rule, no particular trouble need be expected in handling the larger weights, since, owing to their importance, more care is exercised in making hitches and other preparations, and usually the foreman, or some other leading man, sees that every accident is guarded against. It is from pieces of medium weight and light weight, of which a great many are handled every day, that trouble more often results. The man handling so much of this class of work becomes thoughtless, the slings become chafed and worn, and the chains become crystallized by long use. The last is a frequent cause of trouble. There is a great difference between ropes and slings used for hoisting. In ropes the wear can always be seen by the strands becoming frayed, loose or cut. A chain, outside of a few bruises, will not show any signs of weakness; although actually it may be full of small cracks which cannot be seen by the naked under these conditions is rapidly becoming weaker with eye, or it may be much crystallized by long use. A chain each lift; until it finally gives way, letting something fall on the man who used it or, as is more frequently the case, on some innocent shop mate.

But whether anyone is hurt or not, there is always a loss to the factory. Sometimes it may only be a rough casting, but very often it is a piece of finished apparatus on which much time and labor has been spent; and worst of all there is usually urgent need for the apparatus at its destination, and disappointment to follow. Suitable racks should be provided for hanging chains and slings on, and when not in actual use they should be kept on these racks. When not following cranes and making hitches, the followers should be inspecting these slings to detect weaknesses and sorting out the bad ones to have them repaired. These racks also afford a ready means for the head rigger's inspection, who is in charge of all such apparatus, and who should always be consulted when anything of a doubtful character in relation to hoisting comes up.

Knots and Hitches—There are many varieties of hitches and many kinds of knots. A description will be given of the standard hooks, eyes, clevises, etc.



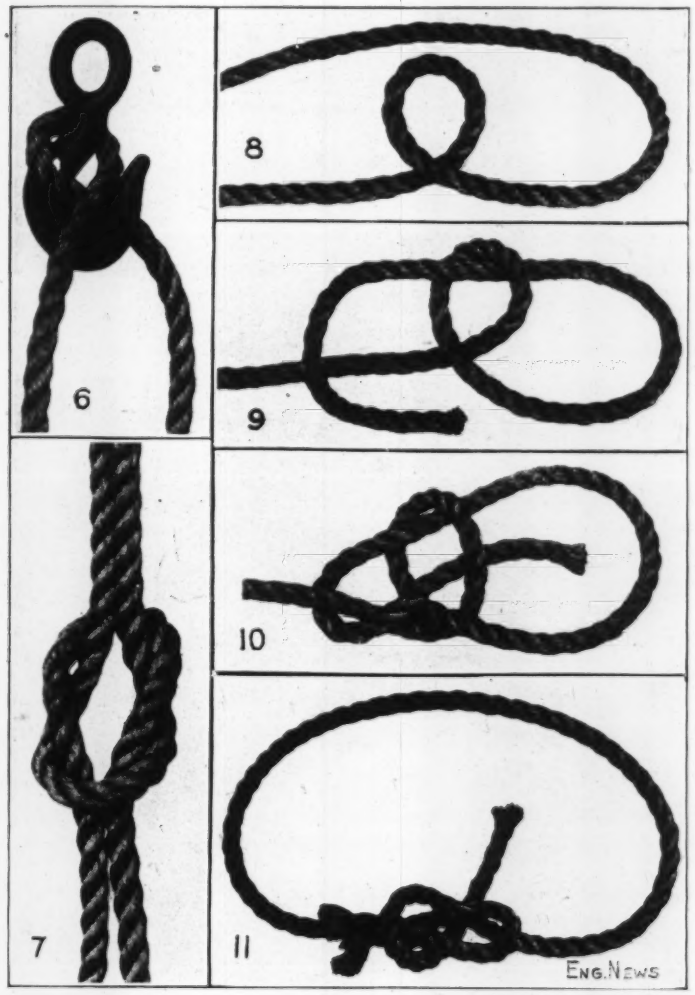
Figs. 1 to 5. Common Hitches for Shop Use

used in general practice. Some knots and hitches will also be shown which are used in special cases, but which are not intended for everyday use in machine shops. They are useful, however, for riggers, millwrights and others handling special machinery and materials, and should be used only by men competent in such work. Figs. 1 and 3 show the method of making the clove or half hitch. This is useful in the hands of a trained rigger, but should not be generally used, except for hauling, when other slings are available. Fig. 2 is the timber hitch, used principally for hoisting rough timber. The studding sail hitch of Fig. 4 may be used very properly for hoisting timber, etc. Where timbers and shafts have to be hoisted in a vertical position the timber and half-hitch combination of Fig. 5 is useful. The blockwall hitch is exceedingly useful where material is to be drawn along the floor, or for drawing cars on a level, and where a hitch is to be made quickly or frequently.

The square or reef knot (Fig. 7) is used only for joining two ropes together; it cannot slip. The bowline knot, when properly made, cannot slip; the three positions of the rope are shown in Figs. 8, 9 and 10. A sheet bend in eye is widely used for an adjustable sling.

*From the "General Electric Review," March, 1913.

†Mechanical Superintendent, General Electric Co., Schenectady, N. Y.



FIGS. 6 TO 11. COMMON KNOTS FOR CRANE SLINGS

It can be changed quickly and is safe and useful in the hands of trained riggers.

The equalizer beam of Fig. 12 is used with two cranes of different load capacity when lifting a weight too great for one. For instance, in the case of a 9-ton weight to be lifted by a 60-ton and a 30-ton crane, the hooks of the equalizer should be located to bring the center of the weight one-third the length of the beams from the end attached to the 60-ton crane.

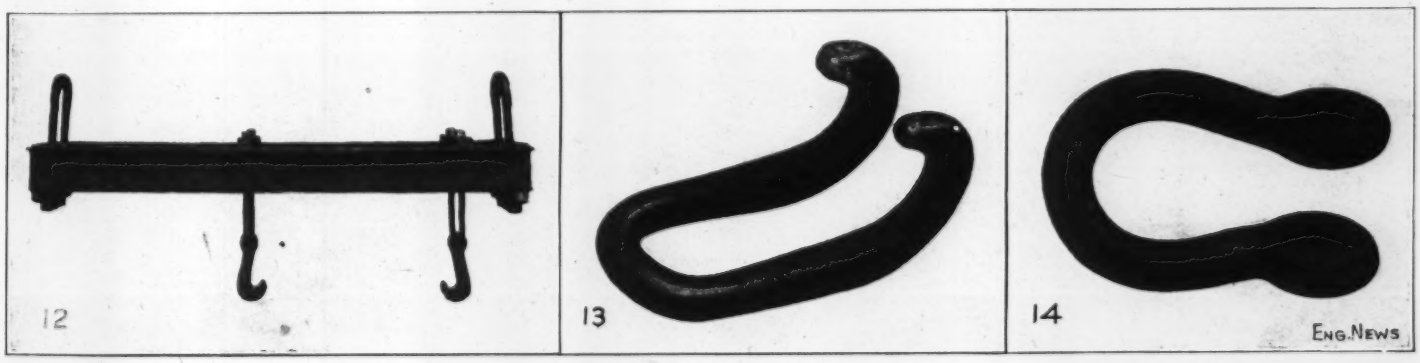
The double hook (Fig. 13) is used for flat disks and flanged pieces when a hook is proper. They should never be used on the inside of a hole or bore in a casting when liable to slip. It is preferable also to use three equally spaced around the circumference of the piece to be lifted. A shackle (Fig. 14) may be used when a bolt can be passed through a hole or opening in the piece to be lifted.

WIRE CABLE SLINGS—Wire cable slings occupy a very important place in hoisting, and have been found very satisfactory when carefully used. A wire cable sling should never be used singly when hooked by a spliced eye. When the weight is sufficient the cable is liable to untwist, thus allowing the splices to open and slip (see Fig. 17). Such slings should always be used double (except where it is impossible for untwisting, as in Figs. 27 and 28), and where sharp corners or rough castings exist the cable should be protected by pads (see Fig. 18). Another method of protecting the cable is by two loose metal blocks that should be perfectly free to adjust themselves and afford ample protection for the slings so used.

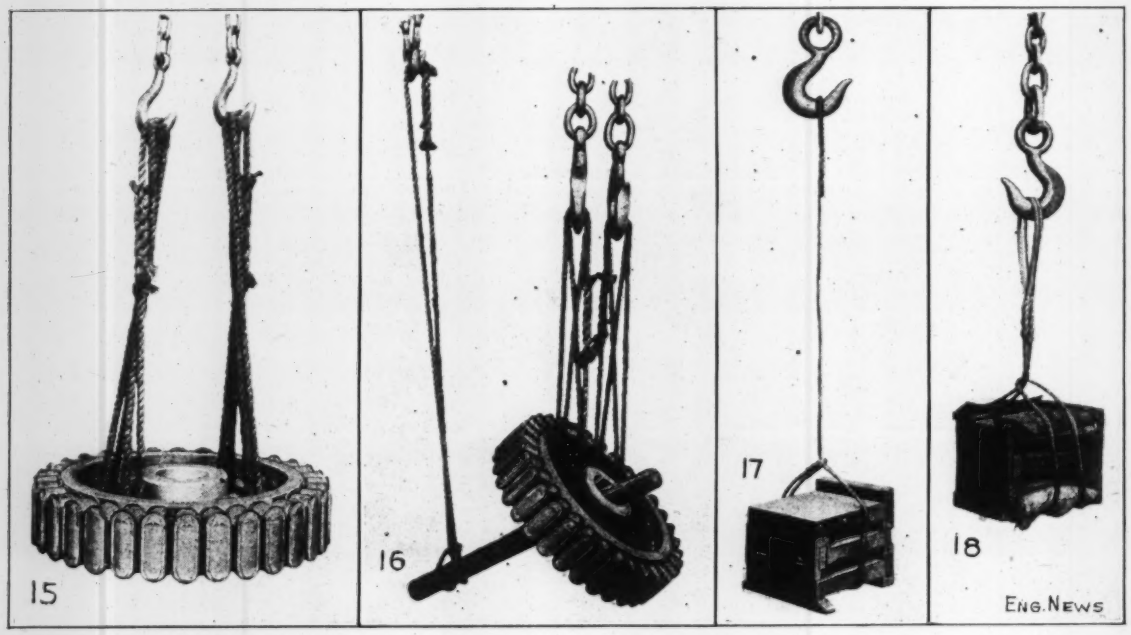
In using slings of any kind, especially rope, care should be taken to see that they are properly laid; i.e., to see that one rope does not lie on top of the other, as this will prevent proper equalization, putting an undue stress on the outer rope. It very often happens, when a rope sling is used double, that the ends of the rope are passed through the doubled part, as when placed around a casting; and, unless this is done carefully, instead of having the strength of two parts of a rope, as supposed, it can be so slipped around the casting, or other piece being lifted, as to actually only have the strength of one part.

SUDDEN STOPS—Before lifting heavy crane loads, the crane brakes should always be tested to see that they are in good condition and will hold. Care must be used when lowering loads to limit the speed, which should not exceed the hoisting speed of the crane for the same load. Particular care must be taken to apply the brakes gradually when bringing the load to rest. The ordinary hoisting speed for a 30-ton motor-operated crane is about 18 ft. per min., and for a 50-ton crane about 12 ft. per min. with the rated load. Stopping the load at such speeds within a distance of $\frac{1}{8}$ in. may double the stress on the slings and crane. *This point cannot be emphasized too strongly; as, in more than one instance, serious accidents have resulted from the sudden stopping of cranes while the load was being lowered.*

STRESSES IN INCLINED SLINGS—When a weight is lifted by two or more slings connected to the crane hook and making an angle with each other, the increase in the stress of the individual slings must be considered. On account of this angle between the two sets of slings the stress on each set is greater than half the total load, and increases very rapidly as the angle between the sling and the work is decreased. An angle of 45° between the sling and the work makes the stress in each sling three-fourths of the total weight, and the collapsing force between the two points of attachment to the work is equal to one-half the weight. This collapsing force acts in a



FIGS. 12 TO 14. EQUALIZER BAR, DOUBLE HOOK AND SHACKLE



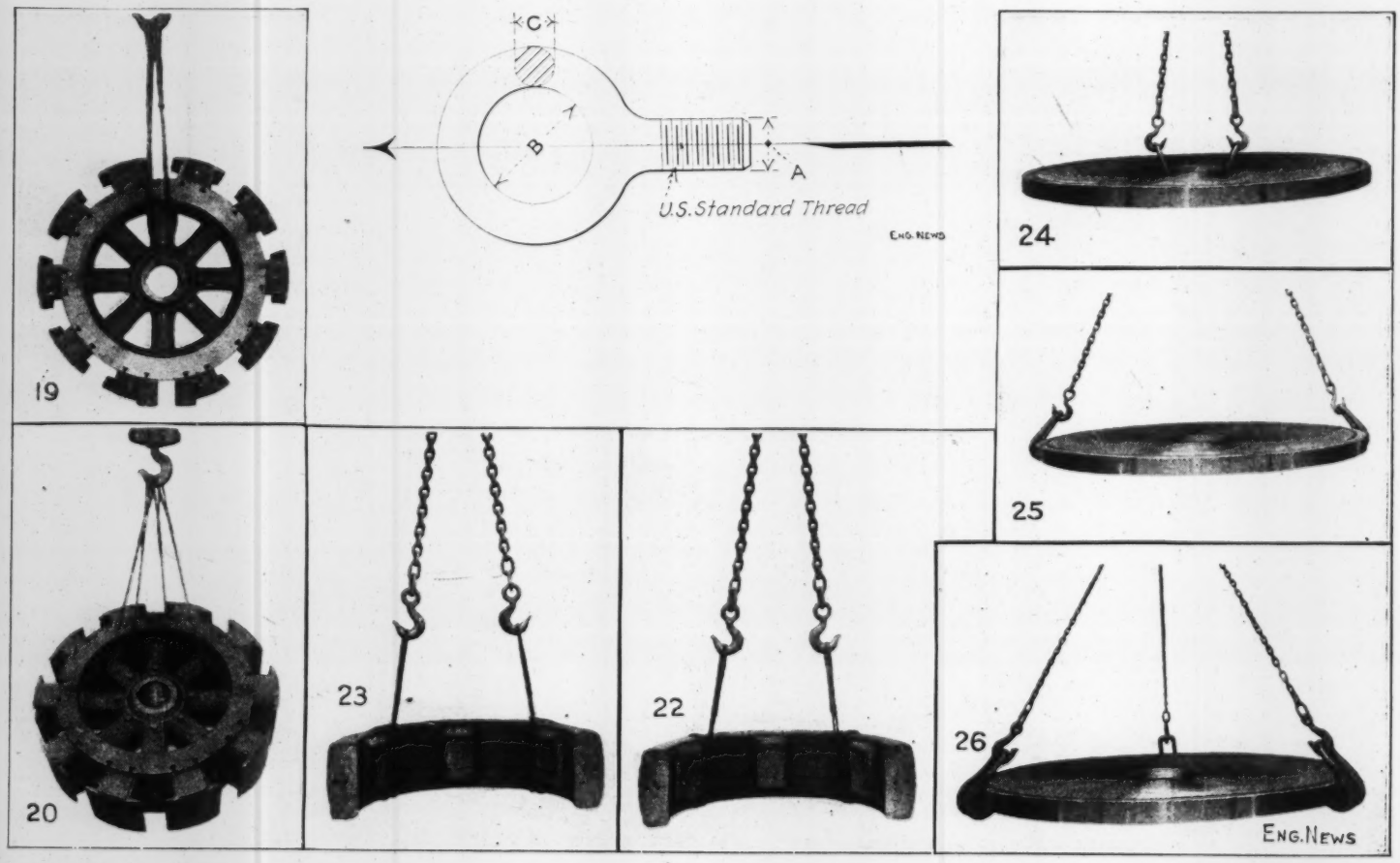
FIGS. 15 TO 18. GOOD AND BAD CRANE PRACTICE

direct line between the two points of attachment. If the work is ring-shaped, it would tend to deform the ring. A spreader of sufficient stiffness should be used between these two points to resist this collapsing force. It will be seen that eyebolts are not suitable for attaching the slings to the work unless a spreader is used to relieve them of this side pull, which would put a heavy bending moment on the shank of the bolt. Reducing the angle between the sling and the work to 30° makes the stress in each sling equal to the total weight, and the collapsing force is also equal to the total weight. Such a small angle should never be used if avoidable.

TABLE I. SAFE LOADS FOR EYEBOLTS
(See Accompanying Figure.)

	Inches A	Inches B	Inches C	Safe Load Lb.
Drop-forged steel	½	1 1/8	7/16	1,100
	9/16	1 3/16	1/2	1,500
	5/8	1 11/16	9/16	1,800
	3/4	1 1/2	5/8	2,800
	7/8	1 15/16	3/4	3,900
	1	2 1/16	13/16	5,100
	1 1/4	2 5/16	1 1/16	8,400
	1 1/2	2 9/16	1 1/8	12,200
	1 3/4	3 1/16	1 1/2	16,500
	2	3 1/16	1 5/8	21,800
D.B.G. Iron E.L., 28,000 lb. per sq.in. welded	1 3/4	3	1 1/4	10,000
	1 3/4	4	1 1/2	11,000
	2	5	1 3/4	14,000
	2 1/4	6	2	16,000

EYEBOLTS—When it is necessary to use eyebolts for



FIGS. 19 TO 26. GOOD AND BAD CRANE PRACTICE

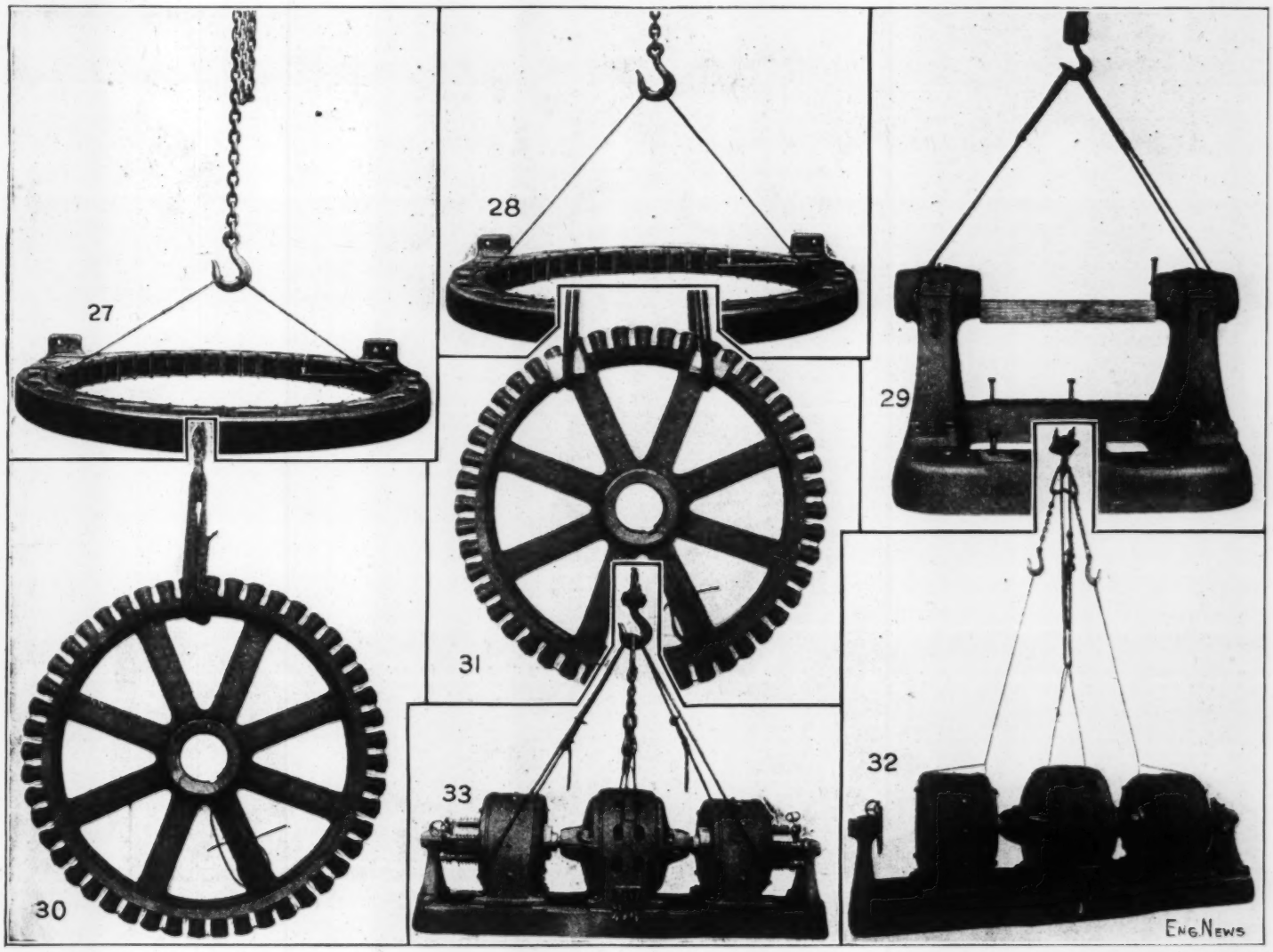
lifting loads, no greater strain should be allowed than given in Table I, which gives the safe load in pounds for bolts up to and including 2¼ in. diameter. It should be noted that the values given are correct only when the pull is in the direction of the arrow shown in Fig. 21, and when the bolt is in good condition.

It should be understood that, to obtain the greatest strength from an eyebolt, it must fit reasonably tight in the hole into which it is screwed, and the pull applied in a line with the axis of the screw. Eyebolts should never be used if considered the least faulty. They should never be painted when used for miscellaneous lifting, as paint is very apt to cover up flaws. They should be tested occasionally by tapping gently with a hammer, but not sufficient to bend or to otherwise injure them.

strain is carried by two ropes or chains, the loads given in the third column should be used. In a sling where four parts of the rope or chain carry the load, the figures in the fourth column should be used. Figures are in tons of 2000 lb.

TABLE II. SAFE LOADS FOR ROPES, CABLES AND CHAINS

Manila rope				Wire cable				Chains			
Diam. rope in.	Safe load in tons Single rope	Two part	Four part	Diam. Cable in.	Safe load in tons Single	Two part	Four part	Diam. Chain in.	Safe load in tons Single chain	Two part	Four part
½	⅛	¼	½	½	1	2	3½	¼	½	⅞	1½
⅝	¼	½	¾	⅝	1¼	3¼	6½	⅜	1	1¾	3
¾	⅜	¾	1¼	¾	2½	4½	9	½	2	3½	6
⅞	½	1	2	⅞	3¼	6	12	⅝	3	5	9
1	⅝	1½	2½	1	4	8	16	¾	5	9	15
1¼	1	2	3	1¼	6	12	24	⅞	6	10½	18
1½	1¼	2½	4	1½	10	19	36	1	8	14	24
1¾	2	4	6	1¾	13	25	48	1⅛	11	19	33
2	2½	5	8	2	16	32	60	1¼	13	23	39
2¼	3½	6½	11					1½	18	32	54
2½	4½	8	13								



FIGS. 27 TO 33. GOOD AND BAD CRANE PRACTICE

If it does not impart a good ring, one of two things is the reason. It may fit too loosely in the hole, or there may be a flaw.

Where a bolt is to be used for anything like its maximum load it should be screwed in tight with a bar and given a gentle tap with a bar or hammer to see if it imparts a solid feeling. If not, it should not be used.

ROPE AND CHAIN LOADS—Table II gives the safe loads which may be put on manila rope, wire cables, and chains. The first column gives the diameter of the rope or chain, the second column gives the safe load which the rope or chain is to carry singly. In a sling where the

The loads for manila rope should be used only when the rope is in fairly good condition; when badly chafed or worn the load should be reduced in proportion.

LAG SCREWS, ETC.—A wood or lag screw, when made in the form of an eyebolt, should never be used to hang any hoisting tackle on. Whenever possible the safest way to hang such tackle is by passing the shank of an eyebolt through the floor or beam, properly protecting the wood by a large plate washer and nut. It frequently happens that a chain or rope sling can be used by passing it over a properly secured timber.

There are several good ways of doing things, and many

wrong ways. Care should always be used to see that they are done in a good way. A few instances may be noted: (1) In turning over a casting like a flywheel or revolving field, a double set of slings should be used on the main hoist to lift the field high enough for turning, padding being used wherever necessary to protect the slings from sharp corners (see Figs. 15 and 16). The field having been hoisted high enough for turning, a piece of timber or scantling should be placed through the bore of the field, the other end of the scantling to be connected to the "small hoist" by the sling; then by lifting on the "small hoist" and lowering on the "main hoist" the work is turned over. Great care should be used, especially against chafing or cutting of the slings. (2) An improper method of making a hitch for such work is shown in Fig. 19. As the slings are liable to be of different lengths the whole or greater part of the load would come on one sling. Slings when used as shown in Fig. 20, permit of enough slip to equalize or give an equal pull on each part of the sling. (3) The method of making a hitch shown in Fig. 22 gives a one-part cable, due to sharp bend and loop in sling. The right way of making a hitch is shown in Fig. 23, the friction of the cable around the object giving approximately a two-part cable. (4) The double hook should never be used as shown in Fig. 24. The correct position when two double hooks are used is seen in Fig. 25. Where possible use three hooks as in Fig. 26. (5) Frequently a base and standard are lifted and no provision is made for any lateral strains that may occur; tending to place an unnecessary strain on the bolts fastening the standards to the base. When such a lift is to be made, a piece of timber should be placed between the bearings to relieve the strain, as shown in Fig. 29. (6) When the slings are used between two arms of a wheel, as in Fig. 30, the entire strain of lifting, coming in one segment, would, if the weight were great enough, crack or break the piece. Two or more double slings should be used, as in Fig. 31, depending upon the weight, the slings to be placed behind two adjacent arms and protected by padding. (7) In Fig. 32 there are a number of sharp corners unprotected while the manila rope sling passes through the loop of the wire cable, and the arrangement of the outside slings does not permit of an even distribution of the load. A better way is shown in Fig. 33.

Case after case might be enumerated; but enough has been said to enable any person entrusted with this work to be able to decide on a proper method and the proper slings or other apparatus to be used. Where he is in doubt as to the weights to be lifted or methods employed, he should seek advice from those qualified to give it. For the guidance of those engaged in handling or lifting pieces it is also suggested and urged that all irregular-shaped castings, and in fact all castings weighing over a ton, should have the gross weight marked in plain figures. It is always safer to over-estimate a weight than to under-estimate it; and it is always safer to use slings of ample lifting capacity than those about which one is in doubt.

Other defects besides those in lifting apparatus will occasionally be discovered, such as a cracked arm of a flywheel, or other similar piece. If this defect is discovered by the person originally handling the piece, he should call his superior's attention to it immediately upon making such discovery.

A reduction in the number of crane accidents can only be effected by extreme vigilance. The loss of material in the past has been very great. The suffering to humanity caused by thoughtlessness has been as great. If proper care is exercised such accidents can almost be totally avoided.

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Carbon Dechlorination of Chlorinated Water Supplies in England*

By Alec C. Jarvis†

In the United States and Canada, so far as the writer is aware, no special means are provided for eliminating from a water treated with hypochlorite any surplus free chlorine which is may contain, except that time may be given (by means of storage) to allow the hypochlorite to become broken up and dissipated.

In England, except in a few cases of urgency [typhoid epidemics—Ed.] hypochlorite treatment has practically only been adopted combined with a patented process for eliminating the free chlorine from the water after the germicidal action is complete.

This process, which is patented and is controlled by a well known English firm of mechanical filter makers, consists of first dosing the water with the hypochlorite, allowing a definite time for it to destroy the bacteria, and then passing the water through a bed of prepared vegetable carbon‡ which has the property of entirely removing any taste or smell. The precise action of the carbon in this respect is not clear. It does not apparently collect any free chlorine gas; it may, however, assist in the breaking up of the unstable hypochlorite and absorb more or less of the free oxygen produced, but as will readily be understood the quantity of hypochlorite dealt with is so small that it is almost impossible to find out what does become of it, nor is the point of sufficient importance to warrant a thorough research, it being sufficient to know that the carbon will do the work.

In course of time, which may be as long as two years (continuous working) the carbon becomes exhausted and requires renewal. Heating to redness in the absence of air, however, revivifies it. This combined chlorination and dechlorination has been developed on both gravity and pressure lines. There are plants in operation on pumping mains direct to consumers and on gravity supply mains also. In some cases filtration is combined with it in the same plant.

There is one case where a town takes its supply from a small navigable river, the water from which in times of flood is turbid and colored. At the intake this water flows through some rough pre-filter chambers and is then raised by water-wheel driven pumps to the service reservoir. On the way it receives a dose of alumina and a dose of chlorine, and passes through a battery of pressure filters where it is filtered and allowed time for germicidal action. Lastly, it is dechlorinated, eventually

*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, at Champaign, Ill., Mar. 11, 12, 1913.

†Water Engineer, Honor Oak Park, London, England.

‡In a paper by A. Lederer and F. Bachman, of the Sanitary District of Chicago, presented at the same meeting, the use of charcoal for removing the taste was not favored; sodium bisulphite or sodium thiosulphate were recommended, the latter being preferable. That paper also supported Mr. Jarvis' opinion as to the relatively small amount of attention given in this country to the question of freeing treated water from taste.—Ed.

reaching the reservoir, clear, bright and almost sterile. There are no sedimentation basins and the filters run about five days between washings, working 24 hours per day. Of course after pre-filtration the turbidity is not great, and the quantity of alum used is small. Another interesting case is that of a town where the water from a stream gravitates through slow-sand filters and is then pumped to the consumers. The sand beds, with the greatest of care, would not produce a good water bacteriologically, and as polluted surface water enters the clear water basin (an old one) through cracks, which for various reasons it would be difficult to stop, it was decided to treat the supply on the pumping main. This has been done with success. The water passes from the pumps through a battery of cylinders, having dechlorinated beds in the lower portion, the upper portion giving the water "contact time." Hypochlorite solution is injected into the inlet main to the battery.

In the case of the town being threatened with a typhoid epidemic, the water is taken from a river, pumped through some old clarifying boxes containing gravel, into sand beds from whence it gravitates to a clear-water well and is pumped to the consumers direct, the surplus being received by high-level reservoirs. The supply even after filtration has always been more or less unsatisfactory, the river being sewage polluted and the sand bed area inadequate. The ubiquitous B. Coli were very much in evidence and when a serious typhoid outbreak occurred at a small town only 10 miles up the river, which discharged all its sewage into the river in an absolutely crude state, it was felt that the situation was somewhat alarming, especially as the threatened town formed part of a high-class seaside resort to which a typhoid epidemic would have meant ruin, or something near it. The Local Government Board called the water authority to take immediate action, which resulted in the author arriving on the scene at 3 a.m. one Friday morning last September to devise some scheme that could be carried out with the existing works in the least possible time, and to satisfy the eminent scientist who had been called in by the water authority.

The difficulty was not so much the chlorination as the dechlorination of the supply. Absolute freedom from taste or smell was insisted upon, as any suspicion of "flavor" in the water would have started a scare. Friday was spent in carefully examining the works and the conditions of working, and (having decided upon a plan of action) in telegraphing and telephoning to London for dechlorinating carbon and the various materials required. A start was made at 6 a.m. on Saturday, later in the day the consulting scientist arrived and approved the author's proposed method of treatment. Work was continued on the Sunday, Monday and Tuesday. Materials arrived slowly, delaying the work, but by Wednesday all was completed, the town safe from a waterborne typhoid outbreak and was enjoying a clean and wholesome supply.

It was decided to treat the water after filtration, and before it reached the clear water well. The first four sand beds are small and two of these were utilized. One of them was entirely emptied of material and cleaned, and another emptied down to the gravel and drains and washed clean. The first was used as a "contact" or "time" chamber, and timber baffle partitions were put in to insure the full capacity being utilized. A hole was cut through the wall near the top and a 10-in. pipe cemented in, to pass the water into the other bed. This latter was filled with carbon on the existing gravel to a depth of 2 ft. and a foot of grit and gravel was spread over it to keep it from floating up. All this grit and gravel had to be sifted and washed from the material removed from the first bed. A siphon of 8-in. cast-iron pipe (the largest available) was made up, connecting the filtered water chamber with the "contact" chamber. A small semi-rotary pump was rigged up to exhaust this syphon.

The sluice was dismantled and a sheet iron rectangular notch put in its place, with a hook gage to ascertain the flow and thus enable the chlorine to be regulated accordingly. The building containing the rough gravel clarifier boxes was used to house the chlorinating apparatus, which was made up with a double compartment tank found on the works, a small ball valve balancing tank, a special hand-grinding mill for mixing the bleach with water, and the necessary pipes, valves and fittings. The solution is regulated by a cock on the balancing tank (with an independent cock for shutting off) and runs by a funnel and wrought-iron piping to the chamber.

One compartment of the solution tank is in use while the contents of the other is settling ready for the following day. The quantity is one part of available chlorine per million. When all was ready, the sand-filtered water was sent to the contact chamber. Both the contact chamber and carbon bed had been partially filled previously. The air in the siphon was then pumped out, and the water duly flowed over, the chlorine was turned on, and the water run to waste until clean, when it was let into the clear water well.

The dirtiest sand beds were then rapidly run off, cleaned and put to work again to keep the loss of head down to a minimum as there is no fall, all the beds being on a level. The clear water well is the only exception, being 2 or 3 ft. lower than the sand beds. Since the treatment was commenced the water has been absolutely free from bacillus coli and the town has not had a single case of typhoid fever. The capacity of the pumping plant is 30,000 Imp. gal. per hour.

❖

A Record Waterwheel Efficiency of 93.7% is reported from tests of units recently installed in a plant of the Appalachian Power Co., at New River, Va. Here four single-runner single-draft-tube vertical-shaft Francis turbines, operating under 49-ft. head, each drive a 4000-kw. alternator at 116 r.p.m. A roller bearing on the top of the generator supports the rotor. As some 1200 sec.-ft. of water is required at full load, the quantity passed through a wheel under test, was measured by a sharp-crested weir across the tailrace, which is 12 ft. deep by 90 ft. wide in solid rock. The crest of this weir was 82 ft. long and tests showed the leakage at zero head to be 0.14 sec.-ft. Allowance for leakage was increased to 1 sec.-ft. to compensate for increased head on the weir and for leakage through the power station. The generator carried commercial load adjusted for a unity power factor. Head on the turbine was determined by a piezometer tube. The maximum efficiency rose to 76% at 2100 hp., and to 93.7% at 5600 hp., falling slightly to 91% at 6000 hp. (full gate).

A model runner of these turbines, tested in the Holyoke flume, gave results uniformly 3% or 4% less than the figures quoted. The station efficiency of a generator unit is considered to be about 88% at 4300 kw. and 83% at 4700 kw., with a figure above 80% from 0.6 full load. The performance of these units is credited to care in laying out the approaches and draft tubes so as to avoid eddies. The turbines were built by the I. P. Morris Co., of Philadelphia. The power station was designed and constructed by Viele, Blackwell & Buck, of New York, for H. M. Byllesby & Co., of Chicago. The tests are described at length in the "Electrical World," Mar. 20, 1913.

An Outfall Sewer of Corrugated Iron Pipe and Measurements of its Internal Friction

The use of corrugated pipe of noncorrosive "ingot-iron" for outfall sewers was mentioned in our issue of Mar. 13, and we have received recently from Herbert Nunn, City Engineer of El Paso, Tex., some information respecting a temporary sewer of this kind 3781 ft. in length. The information included a report by F. H. Todd, consulting engineer for the city, on a test made to determine the loss of head in this pipe.

The original outlet for the city's gravity sewer was a little above the bed of the Rio Grande at a point some distance south of the present sewage-disposal plant. After a cutoff was made (about 1898) to straighten the channel in order that the water at flood stage should not overflow the lower portions of the city, the river channel moved to the north, washing away not only the sewer outlet but nearly 1000 ft. of the sewer; the bed of the river was also raised so that the outlet was then nearly 2 ft. below the bed. In order to prevent serious trouble from the backing up of the sewage, especially at flood stage, pumps were installed at the last manhole above the highest water. In 1912 the channel of the river again changed to the south. In the meantime, however, a sewage-disposal plant had been built; but on account of the failure of this plant to perform the guaranteed purification, it became necessary to pump the crude sewage from the plant to the river channel. To do this without nuisance, a pipe was necessary.

The change in the river channel left a distance of 4000 ft. between the treatment plant and the point at which it was desired to discharge the effluent, the entire distance being in the old bed of the stream and the soil being a light sandy silt. In order to carry the effluent by gravity it was necessary to build the pipe line on a terre-plaine or old geological dike 2 to 4 ft. above the general level. The problem was to use a pipe that would stand in light soil subject to overflow, and that could be moved and saved in case the river changed back to its old channel. On account of the location of the international boundary and the laws governing permanent works in river channels, the work could not be protected. It was finally decided to use galvanized ingot-iron pipe 24 in. minimum diameter (25 in. at the convex corrugations). The pitch of the corrugations is 2½ in., and the metal is of No. 16 gage. This pipe line was built in June last. The pipe was laid in 30-ft. lengths with standard riveting and lug connections. Lug connections were used on account of facility in installation, and the ease with which they could be removed in case of emergency.

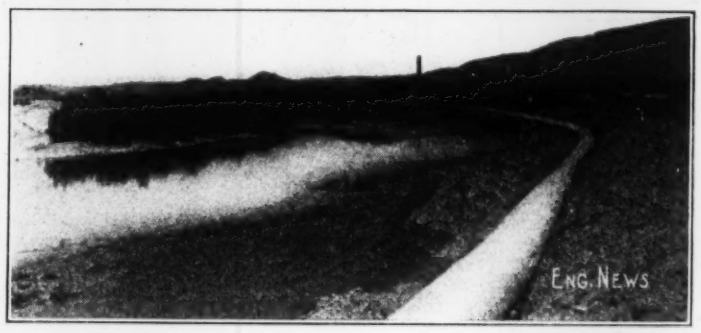
The sewage was turned in about Aug. 1, and the connections showed a light leakage. This was overcome by the use of a bag of wheat bran, and no leakage has since been noted. Some of the joints were asphalted during the installation, but it is found that this was unnecessary. Mr. Nunn states that this pipe-line has been carrying about 3,000,000 gal. of crude sewage per 24 hr. for the past seven months, and a recent examination showed that the galvanizing had not tarnished and that the pipe is in good condition.

The construction being of a temporary character, no effort was made to lay the pipe to a perfectly true grade. The elevations are approximately 98.6 ft. at the head of the line, 95.25 and 94.6 ft. at the first two measuring stations (1038 ft. apart) and 92 ft. at the outlet (1770 ft. farther). The pipe begins about 136 ft. from the disposal plant, and is connected to the pumps by a 12-in. wrought-iron pipe. There are two right-angle turns, at one of which is a drop of nearly 3 ft. in the grade line; beyond this the pipe is laid about on the surface of the ground. The lower portion of the outlet is laid on a long curve in plan. In most cases the lengths of pipe are overlapped one corrugation.

As this pipe was laid in the summer of 1912, it has not been in use long enough to see if there is any corrosive action from the sewage, which has been so long in the sewers as to be somewhat septic. Comparatively little storm water or ground water is taken into the sewers, and consequently the domestic sewage is highly concentrated.

Measurements of Internal Friction of Corrugated Pipe

Some experiments were made to determine the loss of head in pipe of this kind, for which purpose three measuring stations were established, two on the straight portion of the pipe (1038 ft. apart) and one at the outlet



Temporary Outfall Sewer at El Paso, Tex.; 24-In. Ingot-Iron Corrugated Pipe

(1770 ft. below the second). The outlet was partially closed by a partition across the lower part, so that the pipe flowed full. There were no deposits in the pipe at this obstruction, and none were apparent in the pipe after the obstruction was removed. A weir and concrete approach channel were built in the river bed. The average velocity in this channel was about 0.5 ft. per sec. The weir notch was a rectangular opening 5 ft. long and 7 in. deep, cut in a sheet of No. 16 galvanized iron stiffened with boards on the downstream side.

Readings of the head of water flowing over the weir were taken at 15-min. intervals for 25 hours in order to determine the rate of flow of the sewage. The calculated result for the flow over the weir was about 2¾% less than is given in Trautwine's tables for weirs without end contraction.

The loss of head between measuring stations was determined by means of manometers showing the head at each station. These were made of ⅛-in. brass tubing, the inside end of the tube closed and a ⅛-in. hole drilled into the side of tube. This tube was placed horizontally and inserted in a hole drilled at the concave corrugation of the sewer pipe (its smallest internal diameter), a piece of rubber being used as a gasket. The horizontal tube was supported on a board, and from its outer end a rubber tube led to a vertical glass tube so

that the height of the sewage could be seen. Behind the upright tube was a paper scale graduated to $^1/_{50}$ in. the zero of which was set with a level, so that the relation of the manometers could be referred to the same plane.

At the different stations, simultaneous observations were made at intervals of 1 in. in the horizontal diameter of the pipe, thus observing the effect of the corrugation. While making the observations for this purpose the opening in the brass tube was against the current. The first readings at stations Nos. 1 and 2 (on the straight pipe) began at 1 in. inside the pipe and continued at 5-min. intervals for each additional inch as the tube was pushed in until it reached the center of the pipe. The readings showed a uniform increase in loss of head from the inside of the pipe to the center, and the loss of head between the first two stations (1038 ft.) was 1.46 ft. at 1 in. from the side and 1.72 ft. at the center.

Mr. Todd states that from the results of the observations it appears that for velocities approximating 1.5 ft. per sec. in 24-in. corrugated pipe, the coefficient n in Kutter's formula is between 0.0212 and 0.0222. The former is derived from the readings at the ends of 1038 ft. of straight pipe, and the latter from the readings on 2808 ft. of pipe, including the curved portion. The loss of head due to friction, for a flow of 5 cu.ft. per sec. was about 1.49 ft. for the 1038 ft. of straight pipe and 4.37 ft. for the length of 2808 ft.

The Precise Level Net of the United States*

By William Bowie†

Precise leveling was defined in 1867 by the International Geodetic Association as that class of spirit leveling which had a probable error of not greater than 3.0 mm. per km. In view of the remarkable progress made in spirit leveling since then, the Conference of that Association, held at Hamburg, Germany, in September, 1912, decided to establish a new class of leveling to be called "leveling of high precision;" which should have a probable accidental error of not greater than 1.0 mm. per km., and a probable systematic error of not greater than 0.2 mm. per km. Such leveling should be run twice over a line in opposite directions and under different atmospheric conditions, if practicable. Practically all of the leveling added to the precise level net of the United States in recent years has the accuracy of this new class.

PRECISE LEVEL DATUM

The datum upon which all precise leveling is based is mean sea level, which varies within a very small range from year to year, as shown by long series of observations. Two to three years of continuous tidal observations are considered to be sufficient to establish the mean sea level at a given point, which may be considered as having a zero elevation in the precise level net.

The mean level of the sea at all points on the open coasts is supposed to define a level or equipotential surface. Deviations from this condition, if they exist, are not great enough to be detected by leveling. Where the mean sea levels at two tidal stations are connected by precise leveling the discrepancy is so small that it can easily be due to the accumulated errors of leveling.

The great advantage of having mean sea level as the datum for leveling is that the field work may start from many points; valuable checks on the results are obtained; and the leveling of neighboring countries may be joined to form a continuous net over a whole continent. These conditions would not be possible if each country adopted an arbitrary datum.

ADVANTAGES OF A PRECISE LEVEL NET

It is scarcely necessary to point out the great advantage of having accurate leveling extended over a country for the use of surveyors and engineers. It is absolutely necessary to know the elevation of benchmarks within a very small amount of error when extensive topographic surveys and canal work are undertaken, and where such operations will join other extended work.

Erroneous elevations on which contours are based are a source of great trouble. Much of the government surveying necessarily had to precede the precise leveling, but conditions are becoming better from year to year as the precise level net is extended.

THE PRECISE LEVEL NET OF THE UNITED STATES

Precise leveling in the United States has been done by the Coast and Geodetic Survey, the Corps of Engineers, U. S. A., the Geological Survey, the Pennsylvania R.R. and the Baltimore & Ohio R.R.

The first adjustment of the net, which was necessary to obtain the best values for the elevations of benchmarks and to eliminate the discrepancies shown by the several lines and closed loops, was made by the Coast and Geodetic Survey in 1899. The net at that time extended from the Atlantic to and including the Mississippi River. A second adjustment was made in 1903 with additions to the net extending to, and in some places beyond, the 98th meridian. A third adjustment was made in 1907 after the levels had been extended to Seattle, Wash., on the Pacific coast. The successive adjustments necessarily gave different values for the elevations and the changes in certain sections were of such amount that the older values could not be held.

There are now about 28,000 miles (45,000 kilometers) of precise levels in the United States run by the various organizations; 13,900 miles by the Coast and Geodetic Survey, 3500 miles by the Geological Survey, 8400 miles by the Corps of Engineers, U. S. A., and 1300 miles by the Pennsylvania and Baltimore & Ohio R. R. Co's. There are 900 miles classified as miscellaneous. In all about 10,700 permanent benchmarks have been established. The net traverses all the states except seven (five of these being in New England), and there are ten connections with the mean sea level, six on the Atlantic, two on the Gulf of Mexico, and two on the Pacific.

ADJUSTMENT OF ELEVATIONS

An adjustment made recently shows that the net is sufficiently extended and the leveling is of such strength and accuracy that the resulting elevations will be considered as standard and, so far as surveying and engineering purposes are concerned, they may be held for an indefinite period, or even for all time. Nearly all the elevations along the Mississippi River and to the Eastward were changed so little by this latest adjustment that the values in that area, as given by a previous adjustment, can be held as standard. In the future any new lines of precise leveling will be adjusted to fit into the net without in any way disturbing the previously adopted elevations.

As each new line added to the net may have some influence on all or nearly all the elevations, from time to time adjustments will be made which will give the theoretically best values of the junction points of the net, which will be of great scientific interest and value, but such adjustments will not interfere with the standard elevations.

A correction, known as the orthometric correction, made necessary by the nonparallelism of level surfaces at different elevations, is applied to the leveling as actually run on the field before the adjustment. This correction need not be applied to leveling in restricted areas, but it becomes important in extended operations when the country is elevated.

EXTENSION OF PRECISE LEVEL NET

The precise level net is being extended into new areas as rapidly as practicable, and it is planned that eventually each place in the United States will have precise level benchmarks within a short distance (say 100 to 150 miles). The spaces between the lines of precise leveling can have levels established by a lower grade for the control of detail required by engineers and surveyors. The important things are that all elevations should be referred to mean sea level as the datum and that they should be connected with the standard elevations.

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†Inspector of Geodetic Work, U. S. Coast and Geodetic Survey, Washington, D. C.

A Gasoline Rock Drill*

A self-contained rock-drill, which does not require a power plant and pipe line installations, has wide possibilities of usefulness. The gasoline drill which has been developed in recent years has a great opportunity in this field. A new gasoline drill which is the result of several years of investigation and experiment has been invented and patented by L. L. Scott, and is soon to be put on the market by the Scott Drill Co., 1013 Chestnut St., St. Louis, Mo. Mr. Scott's first gasoline drill, which was described in our issue of Nov. 26, 1908, was of the piston type, in which the drill rod has a reciprocating motion corresponding to that of the piston of the operating cylinder, as in a compressed-air drill. His new drill is of the hammer type, in which the drill steel has no reciprocating motion but receives a rapid succession of blows upon the end, these blows being transmitted from the piston of the operating cylinder.*

The drill is in effect a single-acting two-stroke cycle gas engine, and a crankshaft and flywheel are used to effect the return stroke of the piston. In order to permit the piston to deliver a fully effective and uncushioned blow, it is essential that it should be entirely free from connection to the crankshaft or other fixed part at the moment when the blow is struck. The way in which this is effected is one of the special features of the machine and can best be explained by reference to Fig. 1, which is a diagrammatic sectional elevation of the drill. Fig. 2 is a view of the drill in position for working.

The cylinder has a long hollow piston, *A*, the space in the rear of which, at *B*, is the explosion chamber, while the space, *C*, at the forward end of the cylinder is the compression chamber in which the charge of air and gas is compressed to force it into the cylinder through a channel, *D*, outside the cylinder wall.

The front cylinder head forms a guide for the drill steel, and in it is mounted the chuck, *E*, for rotating the drill. In the rear head is the check valve, *F*, through which the explosive mixture is admitted to the chamber. The hammer piston is a long hollow plug, closed at both ends, having in its forward face a hammer-head designed to strike a sliding block, *G*, in the front cylinder head, through which block the blow is transmitted to the end of the drill steel. The rotating chuck has slots to receive lugs on the drill rod, and has a worm wheel, *H*, around its outer face, gearing with a worm, *J*, on a cross-shaft driven by a chain, *K*, passing around sprockets on the main and cross-shafts.

The hammer piston "floats" in the cylinder, having no fixed connections to limit its stroke or movement. Within this piston is fitted a second piston, *L*, of fixed stroke. On the side of this inner piston is a cross pin, *M*, which projects through a slot in the hammer piston and in the cylinder wall. This pin carries one end of a connecting rod, *N*, whose other end is fitted to the crank pin of the main shaft, *O*, which shaft lies above and across the cylinder. Upon this shaft is the flywheel, *P*. A port in the side of the main piston permits air to enter the space, *Q*, between the rear ends of the inner and outer pistons to provide a cushion. The exhaust opening is in the top of the cylinder, near its rear end.

During the backward stroke of the main or outer piston, the explosive charge is admitted to the space, *C*, in front of it, and with the next forward stroke this charge is compressed and forced through the passage, *D*, and admission valve, *F*, to the explosion chamber, or space *B*, at the rear of the piston. With the second backward stroke, this charge is compressed within the rear chamber and a second charge is admitted to the forward chamber. At the end of this stroke the compressed charge at *B* is fired, driving the piston, *A*, forward so that its hammer head strikes the block, *G*, which transmits the blow to the drill rod. This contact with the block occurs just before the crank of the main shaft reaches its dead center, and the momentum of the flywheel causes the crank to continue its motion so that the inner piston slides forward within the main piston, allowing the crank to pass the center without shock to its bearings. As this inner piston moves forward it uncovers the cushioning port above mentioned, and admits air at its rear, which is compressed within the space, *Q*, as a cushion on the return stroke of this inner piston until the pressure is such that the main or hammer piston is moved back with the other. With this arrangement the main or hammer piston is entirely free from the main shaft at the moment when it makes its blow on the striking block. Both the piston and the block are of vanadium steel. The cylinder slides in its mounting and has the usual screw-feed arrangement.

As will be seen from the above description, the drill

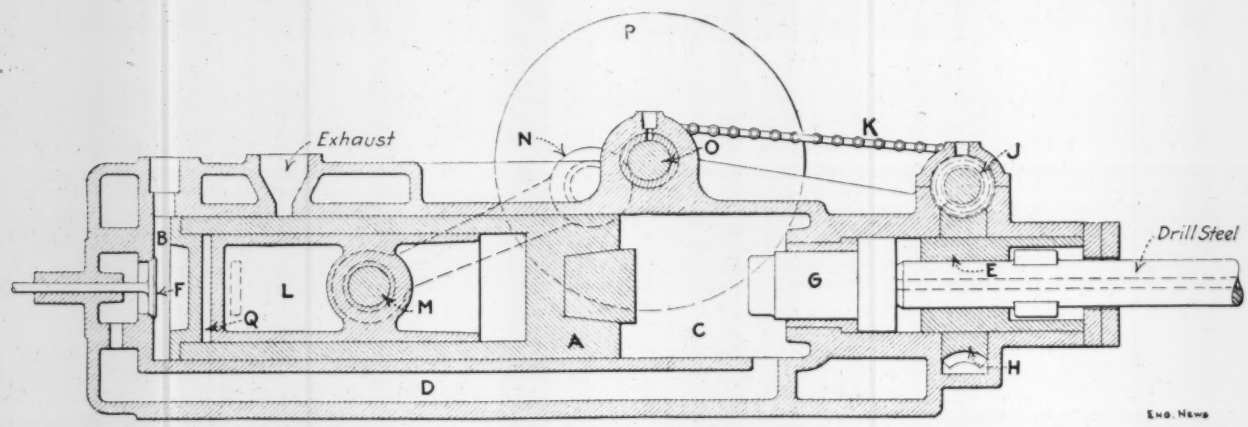

FIG. 1. SECTIONAL ELEVATION OF THE SCOTT GASOLINE ROCK DRILL
(Scott Drill Co., St Louis, Mo., maker.)

*Another gasoline rock-drill of the hammer type was described in our issue of Apr. 13, 1905.

engine is of the single-acting two-stroke-cycle type, of simple construction. The inlet and outlet ports are not opposite each other, so there is no opportunity for back-firing. The speed can be as high as 3000 r.p.m., but can be regulated by the operator as desired. The machine runs with very little vibration when drilling. Cylinder lubrication is provided for by adding a small amount of oil to the gasoline (1 pint to 5 gal.). It will rarely be necessary to provide for carrying away the exhaust, and in fact gasoline locomotives with much larger engines work in mines and tunnels without causing trouble. In close ground the exhaust may be piped into a water sump or to the mouth of the shaft or tunnel, and if the exhaust pipe should be several hundred feet in length, a small suction blower may be put at the end in order to relieve back pressure. A tank located near the drill holds about 2 gal. of gasoline and 15 gal. of water for the cylinder jacket and for washing out the drill hole. Small hose lines run from the tank to the machine. The only other apparatus required is the small battery supplying current for the electric ignition apparatus.

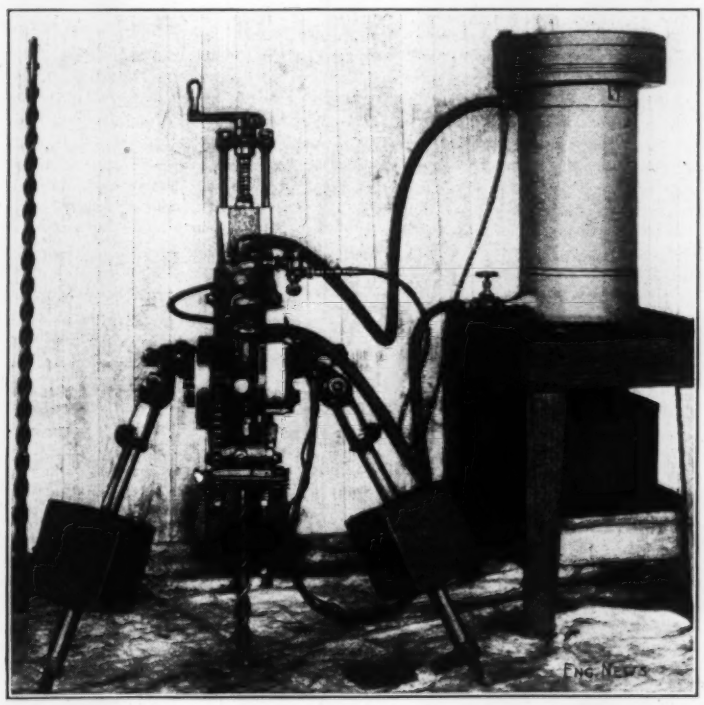

FIG. 2. PERSPECTIVE VIEW OF SCOTT GASOLINE ROCK DRILL

The Scott drill is made in four sizes. The smallest, which can be held in the hand and is adapted for such work as block holing, weighs 48 lb. The others are carried on mountings; one of these weighs 85 lbs., and drills holes 4 to 5 ft. deep. The next size weighs 140 lb. and drills holes 8 to 10 ft. deep. The largest size weighs 265 lb. and drills holes 16 to 20 ft. deep. These weights are exclusive of the tripod or column mounting. The cylinder diameter is 2 in., 2½ in., and 3½ in. in the three mounted sizes, respectively. The average gasoline consumption of the largest machine is 2 gal. for a 10-hr. run. In hard limestone (in the St. Louis quarries where the machine has been tried) it will drill 80 ft. of hole per day; for starting, a 2¾-in. bit is used, and the hole is finished with a 1½-in. drill. Two types of drill rods are used. One of these is a hollow cylindrical rod, and at each stroke a portion of the exhaust is used to force water to the end of the hole, thus removing chips and dirt and keeping a clean rock surface to receive the blows of the drill. The other rod is solid, but has a spiral thread on the surface which acts as a conveyor to remove the chips from the hole. It is claimed that the gasoline drill with 2 hp. has a capacity equal to that of an air-drill requiring some 20 hp. at the power house.

A Plan to Limit Unbalanced Bidding on City Contract Work

A plan to lessen the degree to which unbalanced bidding has been carried on contracts for extending water mains has been devised by the Department of Water Supply, Gas and Electricity, New York City. In brief, it is proposed to prohibit the use of any unit price in bidding which is below the figure set in the engineer's estimate, but to permit a total bid less than the total estimate by deducting a lump sum from the aggregate of the items, this lump-sum deduction to be computed as stated below.

This plan has aroused opposition from the General Contractors' Association (51 Chambers St., New York City) which has passed resolutions of disapproval (cited in Mr. DeVarona's letter below) and which has commented on it adversely in its *Bulletin*.

The Department of Water Supply recently issued the following memorandum on the proposed plan:

> In the schedule of quantities inserted for the information of bidders there is to be given a minimum unit price for each item, which, in general, would represent about 75% of the current market price for the material and labor called for, the sum total of the contract based upon such minimum unit price being given. The following paragraphs, which it is proposed to insert in the contracts, give the necessary information to the bidder as to how bids are to be submitted:
>
> No bid will be accepted in which the price bid on any item is less than the engineer's minimum unit price for that item, as given in the foregoing statement.
>
> If the bidder, however, wishes to submit a bid which will total less than the total estimate based upon the engineer's estimate of all the items and quantities, with their corresponding minimum unit prices (A), he may bid a lump sum to be deducted from his total estimate based upon the approximate quantities and the unit prices bid, but provided his total estimate shall not exceed (A + 20%), which is 20% more than the total estimate based on the engineer's minimum unit prices and approximate quantities. This lump sum deduction shall be inserted in the bid and will be used in the comparison of bids.
>
> From the final estimate there shall be deducted a lump sum equal to the lump sum bid to be deducted divided by (A), and multiplied by the estimated cost of the contract, based on the actual quantities and the engineer's minimum unit prices. Proportional deductions shall be made from the partial estimates forwarded for payment under the contract.
>
> From the above it will be seen that the bidder is not limited as to the maximum price he may place on any item, and he can unbalance his bid, but such unbalancing is limited owing to the minimum price that is fixed for each item. At present it is the general practice among the contractors to bid on water-main contracts, 1c. for the majority of the items and load their entire contract price on a very few items.

The *Bulletin* of the General Contractors' Association comments on the foregoing plan as follows:

> At the meeting of the Executive Committee, on the 5th instant [March?] this remarkable method was considered. All of the comments were not recorded in the minutes, but the consensus of opinion was that the famous puzzle regarding the age of Ann had been surpassed. **How much is A?**
>
> We confess it is about as clear to us as Croton water after a spring freshet. The engineer figures his cost price of the **material and labor** for each item, and then advertises 75% of this price as the upset figure which a contractor will be permitted to bid on that item. (Fallacy No. 1. The engineer has little, if any, reliable knowledge as to the actual cost of the work, so why take 75% of something that is wrong at the start?) The contractor may bid as high as he likes on any item, but if he wishes to bid a total less than the engineer's total, his total cannot exceed the engineer's by

more than 20%. In other words, the contractor's estimate of the work cannot exceed 90% of the actual cost of the work as determined by the engineer. And bear in mind that this is the engineer's opinion of cost of material and labor only—no profit taken into consideration at all.

The engineers of the Department of Water Supply, Gas and Electricity complain about the practice of contractors in that Department bidding 1c. on items. Just so long as this Department issues estimates with such outrageously unbalanced quantities as it has in the past, it must expect the contractor will unbalance his prices to meet the conditions as he knows they will be.

There is only one just way to prevent unbalanced bidding and that is to put a stop to the practice among engineers of issuing unbalanced quantities. Engineers take great pride in making public the fact that a contract has been completed at less than the bid cost, but those who are familiar with the game know that far from reflecting any credit, it is really due to a lack of faith in their investigations and the desire to play safe. Legal fraud, some people have called it; and that is expressing it very mildly.

On giving I. M. de Varona, Chief Engineer of the Department of Water Supply, Gas and Electricity an opportunity to explain the plan in more detail, as well as to comment on the criticism just cited, Mr. de Varona wrote us on April 1, 1913, as follows:

The desirability of avoiding the unbalancing of bids, in justice both to the contractor and the department, has been so fully recognized as to need no comment here, and it is equally well known that it is extremely difficult, if not impracticable, to completely prevent unbalanced bidding. The various municipal departments will bear witness to the soundness of this statement, amply borne out by their experience.

Assuming, then, that it may be out of the question to completely eradicate the evil complained of, our efforts should be limited to reduce it, as much as possible, and the method devised by this Department and now under consideration, is intended to effect this purpose. How well it may accomplish it remains to be seen after it has been tried.

A few statements seem pertinent in support of the same, as well as a discussion of the main reasons for unbalancing of bids, especially in the case of contracts for water mains, which are those now being considered. Those reasons may be thus summarized:

(1) The work under contracts for laying water mains, varying but slightly, the contractor desires to withhold from his competitors the knowledge of his true estimate of cost on any contract.

(2) The contractor, especially when limited in financial resources, is anxious of securing as prompt monetary returns as possible from the work. He, therefore, bids an excessive price on the items which will be included in the earliest estimate and thus bring him the speediest financial return.

(3) For reasons to be given hereafter, the engineer's estimates are generally larger than the quantity of work to be done and the percentage of increase in the items which may be called incidental, are normally greater than those on the main items. The contractor, therefore, naturally bids a nominal price on these incidental items.

(4) It is difficult to accurately estimate, in advance, the quantities of rock and earth, and the contractor's judgment in this case frequently differs from that of the engineer.

It is apparent from the above summary, that of the four reasons enumerated, the first two are entirely independent of the engineer's action, while the third and fourth are based upon the accuracy of his estimates and will, therefore, be further explained.

The charter of New York City requires that in every contract an item or items for all classes of work to be done, shall be included, and the corporation counsel advises that in each case the quantities shall be sufficient to cover, not only probable, but possible amounts of work, so that the final estimate shall not exceed any individual item by more than a certain percentage. The latter, in this department, has recently been fixed at 25%.

It follows, that where the known quantity of work is small and yet susceptible of increase during the progress of the work, the addition of an allowance depending on the judgment of the engineer is the only reasonable and safe means to cover unforeseen conditions. To adopt a fixed percentage for these increases is obviously impracticable, especially in the case of small quantities. In fact, in many cases the only practicable increase would be to double the quantities. Take, for instance, that in which it were known that one valve was required; evidently the only possible increase here would be to ask for two.

As to the fourth reason. The quantities of rock and earth to be met with can only be determined by previous tests, the expense of which, as well as the time required to complete them, would be unwarranted in almost all cases. The department, therefore, has to rely on the data secured by a field inspection and from excavations made in the street where the main is to be laid. Where no such excavations have been made, the data necessarily are based only on the field inspection. Furthermore, where rock exists, the general practice of the department has been to place the mains in the excavated sewer trench, and this excavation may be made between the date when the contract is completed by the engineers and forwarded for approval and execution and the date on which the contractor is ordered to begin work. Bearing in mind that this period represents somesix months, the opportunity for a change in actual conditions is evident.

An illustration of these changes, as well as of the motives a contractor has at times for unbalancing his bid and "gambling" on future conditions, seems pertinent here. Under the contract in question, the successful contractor bid 1c. for rock excavation and $2 for earth excavation, and his reason for doing so, as subsequently explained by him, was that while he knew there was rock in the street, he expected that there would be a sewer laid before he was called upon to begin his work and that this department would then change the approximate alignment shown on the plans and order him to lay the main in the sewer trench, in which case he would not only be saved the rock excavation, but would be paid at the rate of $2 a yard for excavating the refilled trench. As a matter of fact, the sewers were and are still being laid in the streets covered by this contract, but the department, of course, refuses to change the alignment and thereby enable the contractor to realize at the city's expense, the profit he anticipated. It is needless to comment on the contractor's disappointment, and on the fact that had the bid been balanced, a change in the alignment could be made in the interest of both contracting parties.

The method of bidding on a percentage basis to avoid unbalanced bids is well known, as are also the evils resulting therefrom, among which may be especially noted that while the contractor is strictly prevented from unbalancing his bid, no such restriction is placed on the engineer in preparing his estimates of quantities, and the contractor is, therefore, practically left at his mercy.

In framing the proposed plan, the following conditions had to be borne in mind:

(1) The contractor must be able to bid whatever total amount he chooses, even if it should be below the actual cost of the work.

(2) The contractor must be allowed sufficient latitude in fixing his prices for each unit of work, so that he may secure adequate compensation even if he believes the engineer's quantities are not accurately balanced.

(3) The contractor must not bid for any item materially below the actual cost thereof. He can accomplish the same end, if he so wishes, by reducing the amount of his total bid.

Our proposed plan conforms, in our opinion, to these requirements. We do not claim that in limiting the conditions we have accurately gaged their relative importance. Neither could, however, our critics at this stage. Like them, we also could see objections to our plan, but have simply done what we deemed best after careful consideration. Experience will determine the success of our efforts.

As to the form of, and objections to, the proposed contract: Were it not for the need of providing for the contingency, however improbable, of a bid lower than the cost of the work, the only modification to be made in the present contracts would be the setting up of the engineer's minimum price for each item to be followed by this paragraph (quoted in "The Bulletin"):

No bid will be accepted in which the price bid on any item is less than the engineer's minimum unit price for that item, as given in the foregoing statement.

The second and third paragraphs quoted in "The Bulletin" state the mode of procedure when the bidder desires to carry out the work at less than the estimated actual cost thereof. Assuming, however, that such case, however improbable, would occur, the bidder would find in the contract the total of the engineer's minimum estimate in place of the letter "A," quoted in "The Bulletin," and experience no difficulty in following the method prescribed.

The assertion made in "The Bulletin's" article, in the final paragraph, that the only just way to prevent unbalanced bidding is that the engineer stop issuing unbalanced quantities, is, in our opinion, in error. It certainly would not prevent the operation of Reasons 1 and 2, already given, as proved by the terms of the resolution adopted by the General Contractors' Association at the meeting of the Executive Committee on Mar. 5, referred to in "The Bulletin," which reads as follows:

Resolved, that the General Contractors' Association is

opposed to any form of percentage bidding and that this opposition is founded on two main objections, namely:

(1) It denies to the contractor the opportunity to arrange his bid in accordance with his own ideas as to the accuracy or probability of the quantities as estimated by the engineer.

(2) By its publication of cost of each item, it encourages laxity in estimating on the part of intending bidders, and makes bidding by incompetent persons much easier than under the unit system of bidding.

The desire of this department to do justice to both contracting parties, cannot, we think, be called into question, and as we see no practical way of avoiding the estimate of quantities somewhat in excess of actual computations, we believe that the method proposed is equitable and workable and feel warranted in so holding until results prove the contrary. Apparently, the underlying reasons for "The Bulletin's" criticisms seem to be that some contractors prefer gambling on the work to be done and disguising their prices, to submitting prices based on estimated actual cost. The resolution of the General Contractors' Association of Mar. 5, given above, tends to confirm this view, which, however, does not commend itself to our judgment.

In connection with this matter, it is pertinent to note that in the bids submitted for hauling and laying water mains and appurtenances in various streets in the Borough of Manhattan, received on Feb. 20, 1913, the majority of bidders submitted a price of 1c. or less on 20 out of a total of 34 items. In the case of the low bidder, there were 24 items on which 1c. or less was bid.

Reports on the Organization of a Highway Department for the State of New York

About a month ago, as briefly noted in ENGINEERING NEWS, Mar. 6, 1913, a commission of 18 members was appointed by Governor Sulzer, of New York, to advise him on the reorganization of the state highway department under a new law enacted by the legislature, the commission serving without expense to the state. After a month of what are reported to be "lively conferences," ten members of the commission have joined in submitting a report. Eight of the members have not signed the report, but three of this minority have submitted individual reports. Also three of those signing the majority report have submitted additional individual reports, leaving five members thus far unheard.

THE MAJORITY REPORT

The majority report is very general but becomes specific in a peculiar way at points which relate to some details of the work which they expect the highway department will administer.

The report calls attention to the combinations of sharp-calked horse shoes, narrow steel tires and automobile wheels which introduce different requirements. It calls attention to the long and severe winter, low temperatures, frost, heavy snows, thaws, and heavy automobile trucks (in that order), showing how the various highway organizations heretofore established in New York have been confronted with the same peculiar problems.

The commission states that it has found it inadvisable to recommend any specific man for consideration for the position as commissioner of highways, the signers contenting themselves with describing the proper man as of "such character and standing as to command the repect and confidence of the public at large, of proven executive ability and capacity properly to organize and conduct the department, and prefcrably a man of experience in road building."

There are 23 numbered recommendations which we have summarized as follows:

(1) Extensive new construction should not be contracted for until the commissioner has ascertained which types have proved best in the state.

(2) The commissioner after organizing the department should cancel contracts and correct specifications or plans for constructions which do not prove to be among the best types which the commissioner should adopt as standard.

(3) Experimentation should be on short sections. Lengths of a few hundred feet, carefully built and observed, serve as well as stretches of several miles.

(4) Not more than 1000 miles of new work should be contracted for in a year.

(5) Contracts for extensive new work should be let in September, October and November with not more than 500 miles of road advertised for letting in one week.

(6) Bids should be advertised for four weeks instead of three. Plans and specifications should be completed and ready for bidders before advertising.

(7) Strict rules for completion of contracts should be enforced.

(8) Radical alterations in character of construction under contract should be avoided. Equitable supplemental contracts should protect the state when changes are necessary.

(9) Deputies and division engineers should be exempt from civil-service rules.

(10) Compensation of the first deputy should be increased from the present $6000 and he should have the powers of a chief engineer under the direction of the commissioner.

(11) The commissioner should bear in mind that roads are not constructed and improved for the benefit of owners of automobiles; he should give attention to the location, construction and improvement of farm roads and should build up connecting links to have a comprehensive continuous system.

(12) Specifications should be simplified and interpretations made uniform.

(13) Proper maintenance and repair should be almost equal in importance to new construction and should be constant, immediate and unremitting. Old macadam roads should be scarified and treated as a resurfacing job with additional stone rolled in place with proper binder. Side ditches should be cleaned out in early spring and late fall. Exuding material on bituminous roads should be covered with sand, stone or screenings. When roads are oiled, one side should be treated at a time; sand or screenings should be used. Trees, embankments and other obstructions to view of vehicles should be removed.

(14) Specifications for bituminous binders should grant no special privileges, but allow fair competition for proper material.

(15) Cement should be purchased by the contractor and paid for by the state instead of being paid for as concrete in place.

(16) Stone or gravel, and not stone alone, should be specified for concrete in all contracts.

(17) Local as well as imported stone should be permitted in the bottom courses of roads, under specified requirements.

(18) Partial payments should be made to a contractor for stone, asphalt, brick or other imperishable materials delivered at the site of work in winter seasons.

(19) The auditing department should be efficient and vigilant; inspection of construction should be constant and unremitting.

(20) The commissioner should have power to enforce provisions relating to traffic regulation.

(21) Damage to pavements or highways caused by rigid attachments to traction engines and such vehicles should be paid for by the owners.

(22) Prompt and better methods of securing rights of way and settling land damages should be adopted.

(23) Short connecting links, between improved roads and the cities or villages into which they lead, should be built without delay.

The report is signed by A. J. Parker, C. E. Treman, G. A. McGuire, W. D. H. Washington, D. B. Cushman, J. McGarvey, H. C. McCord, L. W. Kirwin, A. J. Deer, and J. F. McDonald.

A MINORITY REPORT

Mr. E. W. Stern, consulting engineer, New York City, a member of this commission, in submitting his individual report, stated that the majority report does not express with sufficient clearness and force his views on some matters taken up by the commission. It is believed that Mr. Stern has served, in a measure, as a representative

of the American Institute of Consulting Engineers and that his report has been reviewed by a number of well known engineers. A considerable portion is reprinted below.

ORGANIZATION AND ADMINISTRATION OF THE DEPARTMENT OF HIGHWAYS

It is a prevalent idea with the public that the construction and maintenance of roads is a very simple matter requiring only ordinary business ability. But in no department of Public Works is there greater opportunity for the exercise of sound engineering principles, technical knowledge of the subject, and true economy. A very great deal of money is being wasted every year by the road departments of many of our states in ignorant and useless experimentation on road materials, and methods that have been tried out and long ago abandoned by engineers experienced in this kind of work.

Highways in New York State will never be properly and economically constructed and maintained unless a thoroughly efficient engineering department be organized in conection therewith.

The Murtaugh bill, which reorganizes the department of highways, and which has just become law, unfortunately has **grave defects, both in the entire scheme of organization, and in the small salaries attached to the principal positions.** These defects, unless corrected, would seriously hamper any honest endeavor thoroughly to organize the department on an efficient basis.

My criticisms of the existing law are as follows:

The commissioner is not required to be a civil engineer, nor one who has had experience in the construction of engineering works, nor in the organization of engineering departments. The law would permit a layman to fill this very responsible position. If a layman were chosen, the engineering organization is not properly planned to be efficient, nor to attract to it the right kind of men. There should be, under the commissioner, a **chief engineer of the highway department** who should be directly responsible to the commissioner for all the engineering work, and therefore, **should have full charge and responsibility in the preparing of plans and specifications, execution of the contracts, and of the carrying out of the work, likewise of the maintenance of all roads which come under the jurisdiction of the department.**

The chief engineer should have the right to select his staff, consisting of three assistant engineers and nine division engineers, subject to the approval of the commissioner.

In such an organization, the commissioner would be able to hold the chief engineer entirely responsible. The latter could not then complain about the division of responsibilities which the law permits, in which the chief deputy is really no more than an engineering advisor to the commissioner, and has not any real responsibility or authority in the actual execution of the work, having absolutely no control over the division engineers, who are in actual charge of construction, nor over the second and third deputies, who have entire charge of the maintenance and repairs of all roads.

The bill as framed is not sufficiently exacting as regards the qualifications necessary for the so called **deputies,** and limits the selection from among **those who have had practical experience in construction and maintenance of highways.** The bill is very weak in the use of these qualifications, which would permit a man who had been in such a position as foreman over a gang of laborers employed on road work, to become a deputy, with all the great and highly important responsibilities which attach to the office. Furthermore, it would limit the field of selection to a small body of men.

I would recommend that railroad engineers be eligible for appointment, as the experience in grading, construction of bridges, foundations, drainage, etc., gained in railroad construction is applicable to the similar problems met with in highway construction, and a thorough knowledge of organization and of the handling of men, and of business methods, a thorough practical training in construction, and zeal and efficiency, are among the qualifications of a successful chief engineer of an important railroad. The only qualification he might be lacking in would be experience in the proper surfaces for highways, but given the power to obtain advice from consulting engineers, who have had special experience on this subject, it is reasonable to suppose that a competent chief engineer from one of our prominent railroads might be an ideal selection.

The compensation for the heads is altogether inadequate to attract the proper kind of men to this department. The commissioner should receive a salary of about $15,000 a year, the chief engineer of about $12,000 a year, and each of the assistant engineers, $6000 a year. This increase over the salaries allowed in the Murtaugh bill, amounting in all to only $19,000 a year, ought to enable the state to obtain the services of men who are eminently qualified to fill such very responsible positions.

The law requires that inspectors of construction shall be selected from residents in the county in which the highway constructed or improved is located. While preference should be given to residents, we do not believe that this should be mandatory, as very often the appointment of non-residents might be found desirable, or necessary, and decidedly better for the efficiency of the service.

The chief engineer, the three assistant engineers, and the nine division engineers should not come under civil-service requirements, as these men should form part of the official family of the commissioner, and be removable by him at any time for the good of the service.

SELECTION OF A HIGHWAY COMMISSIONER

The selection of a proper person for the office of commissioner is most important. No matter how good the scheme of the reorganization of the department of highways may be, unless a wise selection for the position be made, radical reform will not be effected.

The commissioner should be a man of such high character and standing as to command the respect and confidence of the public at large. He should be of proven executive ability, with a thorough knowledge of how to organize such a department, and **chosen from the engineering profession if possible.** Otherwise he should be one who has had to do with the construction of engineering works.

TYPES OF ROADS

The particular kind of a road to use in a certain locality is a problem which depends for its proper solution on a number of important factors, such as the kind and amount of traffic, the sub-soil, the climatic conditions, the cost of construction and maintenance, and the amount of money available for construction and maintenance. It would be entirely out of place, therefore, to recommend any particular types of roads, beyond calling attention to the fact that there are two fundamental requirements accepted as axiomatic by all authorities in road building: (1) Perfect sub-drainage and (2) a rigid foundation.

There is no need for extensive experimentation in the near future on the part of the state as to what kinds of roads to build. So many methods have been tried, both at home and abroad, that intelligent investigation of what has been already done would be sufficient to indicate what types of roads and road surfaces should be eliminated from consideration, and what types are best suited for particular localities.

It will doubtless become advisable, from time to time, to experiment with new types, but this may be done on a small and inexpensive scale.

It is important that we recognize the fact that the difficulty of providing durable roads has been greatly augmented by the introduction of automobile traffic; the wear and tear resulting in their use being much greater than from horse vehicles. We must make up our mind to make much more durable types of roads than we have been accustomed to in the past.

There can be no doubt but that the rapidly moving automobile and auto-truck have come to stay. This method of transportation is yet in its infancy, and before another generation, if proper roads shall have been provided to take care of it, the economic benefit to the community, resulting from their use, will be great.

Another important consideration is the fact that the money to construct new roads in this state is raised by bond issues, maturing in 50 years from date of issue. Therefore it would be manifestly unfair to future generations to construct, with this money, roads that last only a few years, if more durable types requiring less annual expenditure for maintenance are economically practicable.

MAINTENANCE

The proper maintenance and repair of existing roads is just as important as the construction of new ones.

It is most important that the department of highways should be thoroughly organized for this purpose, so that repairs may be promptly, economically and efficiently made. By promptly repairing small defects, not only is the road made better for constant service, but also the cost of maintenance is decreased. The amount allowed in the budget for maintenance should be sufficient to avoid any delays in making immediate repairs.

The report closes with a few miscellaneous recommendations on contracts, changes in construction, specifications, short links, etc., quite similar to those noted in the majority report.

A Spring Wheel for Automobiles

One of the schemes over which a multitude of inventors have worked without success is the design of a "spring wheel" for use on vehicles. Many such wheels have been designed and built, but the universal experience has been that the wear of the joints, exposed as they necessarily are to dust, water and mud, has made such wheels impracticable.

The object of most inventors has been to substitute springs in the wheel itself in place of the ordinary vehicle springs. Such springs require, of course, a large range of motion and corresponding movement of the joints. In recent years, however, inventors have sought to devise spring wheels as a substitute for pneumatic tires. Such springs, of course, need have no greater range of motion than the tire itself, that is, a small fraction of an inch. In such wheels motion in the joints can be reduced to a minimum.

A spring wheel of this latter type was exhibited at the recent Motor Truck show in New York City and was briefly referred to in our issue of Feb. 20. At our request, the maker of the wheel, the Seaton Wheel Co., of Nashville, Tenn., has furnished us material from which the accompanying illustration and the following description have been prepared.

Fig. 1 shows a view of the whole wheel as applied to a motor car and in Fig. 2 views are shown of a single spring element. *A* shows the element in an unstrained state; *B*, the same element under stress. This element consists of a stout spiral spring with each straight end

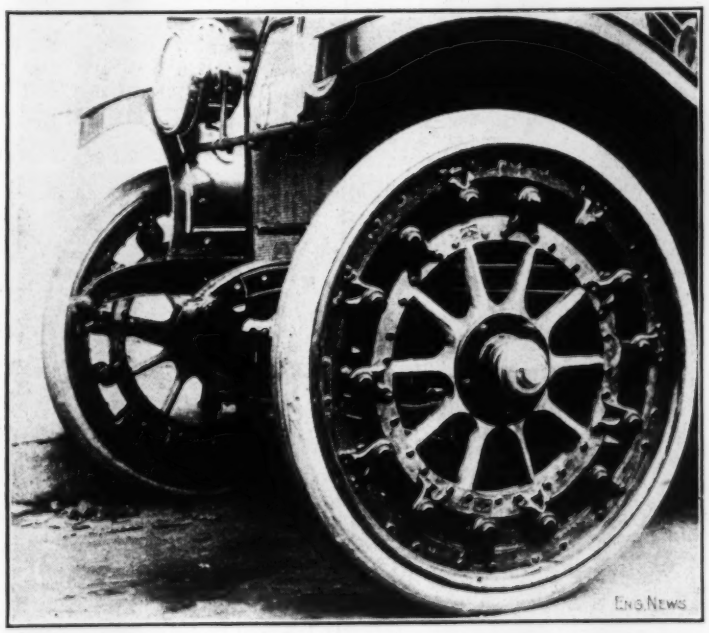

FIG. 1. A NEW TYPE OF SPRING WHEEL APPLIED TO AN AUTOMOBILE

terminating in a ball and socket joint, one of the socket bearings being attached to the wheel rim and the other to the extended hub. The inner and outer of these bearings are attached alternately to the rim of the wheel and to the inner wheel. The ball and socket joints are packed with grease.

Important points worth noting about this arrangement are that, since the rim and the extended hub are both rigid, the total stress due to the load is divided between all the springs on the wheel.

It is claimed also that when the wheel is running at high speed the centrifugal force acting upon the inner wheel, due to the fact that the center of gravity of the rotating rim is higher than the center of rotation of the hub, tends to offset the effect of the load and raise the hub toward the center of revolution of the outer rim.

The practical advantage claimed for this spring wheel is that it permits the use of solid tires on the wheels, while retaining the easy riding qualities of the pneumatic

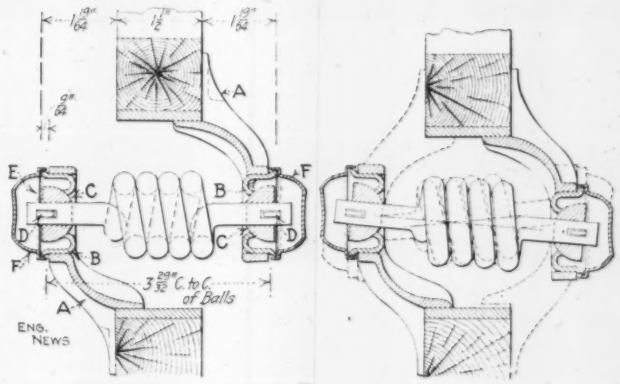

FIG. 2. VIEWS OF THE SPRING ELEMENT (B UNSTRAINED B STRAINED) FROM THE SPRING WHEEL
(Seaton Wheel Co., Nashville, Tenn., makers.)

tired wheel. It is stated that a set of wheels has been run on a touring car over 45,000 miles with no perceptible wear.

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An Investigation of the Efficiency of Trusts was proposed by Hon. Wm. C. Redfield, Secretary of Commerce, in an address before the American Cotton Manufacturers' Association Apr. 9; extracts follow:

I wish to suggest a new subject of inquiry for the Bureau of Corporations. The air has been full for years past of discussion of the trusts. It is alleged upon the one hand that the trusts are necessary for our industrial efficiency. There has been discussion altogether too brief, on the other hand, as to whether the trusts are, as a matter of fact, industrially efficient or not.

A good many years ago the late Edward M. Shepard said to me that he believed the trust form of organization carried within itself the seeds of its own decay; that its economies were more apparent than real and that the serious difficulty in obtaining men who could manage efficiently, with firm grasp and thorough control, these great organizations, would result in ultimate segregation.

The point I now bring before you is this: That we do not know, from any mature and exact study, whether the so called trust form of organization is industrially efficient or whether it is not. We are dealing with it in a sense as a national menace, whereas the fact may be that it menaces chiefly itself and the people that are interested in its securities. Whether this is true or not, I do not pretend to say. It does seem to be sufficiently important to warrant a thorough study of the matter.

Certain economies are obvious in the formation of a trust. Are or are not these economies superficial, in the sense that the formation of a trust brings into action certain less visible but more potent elements that take away from economy? Is it or is it not true that the major motive in the forming of the trust is the profits of the promoters that organize it? Are the economies of centralized organization, of reduced competitive outlays, more than balanced by certain economic weaknesses which do not arise in the smaller concerns?

There is a point, as manufacturers well know, up to which, as product increases in quantity, cost is reduced, by reason of the distribution of the burden charge over a greater output and its consequent reduction per unit of that output. There seems to come a point where this process stops, and beyond which the increase of output is done at an increasing expense. This, of course, varies under different conditions, but there is what seems to be the shadow of a law here which should be more thoroughly understood.

Is it practically possible for men to guide with equal individual efficiency fifteen thousand men, five hundred men, and fifty men? Is there a point where the mere nerves and fibers of the industrial organization required to handle the larger force becomes so complex and delicate that the frictional transmission, so to speak, of the will and thought of the head becomes so great that it is weakened or lost? We hear that the personal relation between master and men is lost; that sometimes the separate units forming the trust operate on a somewhat individual basis, too little related to the policy of the central office. What the precise facts are we do not know. They need to be thoroughly investigated, for we may come to find that the remorseless law of economics is working its way irrespective of legislation, and that the light of economic truth, once found and fully turned upon the subject, may make clear a way which to many has seemed rough and hazardous.

Notes on the Pitot Tube

By John Airey*

Recently the writer became interested in the theory underlying the action of the Pitot tube. A few writers state that $h = \frac{v^2}{2g}$ but do not attempt to prove it as a rational basis. Those who attempt a proof approach the problem by considering the column of water to be sustained by the impact of a jet of water of cross-sectional area equal to that of the pipe. This leads to the result that $h = \frac{v^2}{g}$. The assumption made that the jet is deviated through 90° is admittedly inaccurate, therefore the result is written $h = c\frac{v^2}{g}$, where c is empirical. And then for a reason not very definite another empirical constant c' $(= 2c)$ is introduced and the result becomes

$$h = c'\frac{v^2}{2g} \qquad (1)$$

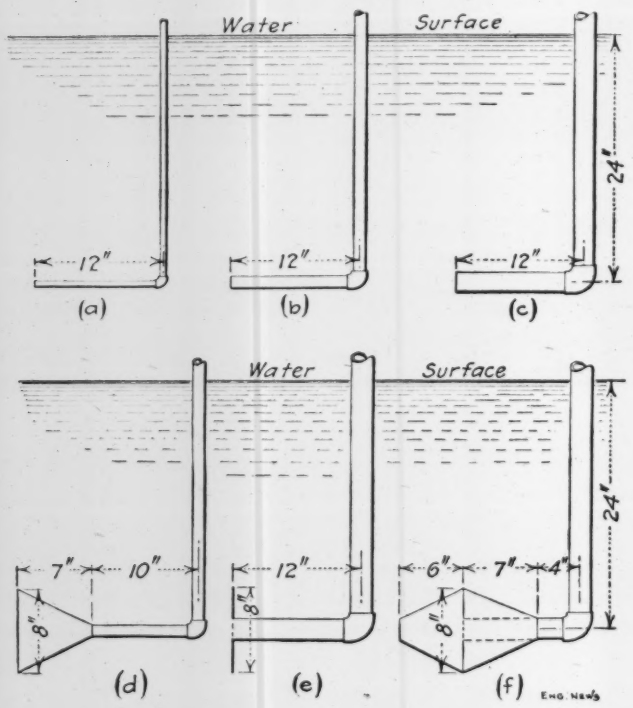

Fig. 1. Six Forms of Pitot Tube Tested

For substantiation and amplification of the above statements any standard textbook of hydraulics may be consulted; also a paper by G. S. Williams (Trans. Am. Soc. C. E., Vol. 27, Parts 1 and 2). In the last-mentioned reference claim is made to having constructed tubes such that c' in eq. (1) was greater than unity, although the tubes actually made use of had coefficients smaller than unity—some of them considerably so.

Church's "Mechanics" states that Weisbach verified $h = \frac{v^2}{g}$ for fine tubes with thick walls, and that Pitot had obtained $h = 1.5\frac{v^2}{2g}$ for a conical mouthpiece. Bazin has, however, obtained results in which the actual head differed from $\frac{v^2}{2g}$ by a small fraction of one per cent. only.

*Department of Mechanical Engineering, University of Michigan, Ann Arbor, Mich.

The writer performed experiments with tubes (a), (b), (c), (Fig. 1), these being made of ½-in., 1-in., and 1½-in. gas piping respectively, and was surprised to find $h = \frac{v^2}{2g}$ to within experimental error, which was under one per cent. This suggested that the momentum theory was quite a misapplication, and that the logical basis was $\frac{v^2}{2g}$.

It is to be noticed that considerations of energy also lead to the statement that $h = \frac{v^2}{g}$, because the work done in erecting a column of water of height h, cross-section a, and density w, is $ahw\frac{h}{2}$. Also the energy previously stored in the same water in kinetic form was $ahw\frac{v^2}{2g}$. If we could assume these two to form an equality the result would be obtained that $ahw\frac{h}{2} = ahw\frac{v^2}{2g}$, or $h = \frac{v^2}{g}$.

The following proof was deduced as establishing $h = \frac{v^2}{2g}$ as the rational basis.

Proof—Fig. 2 shows a horizontal section of the pipe

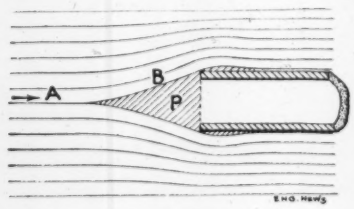

Fig. 2. Sketch of Stream Lines around Mouth of Tubes

with an approximation to the form of the stream lines. The water inside the pipe will clearly be dead, and this dead water will extend into some region outside the pipe as shown by the shaded area. The legitimacy of the proof depends in no way on the particular shape of this area. Assuming that smooth motion exists, i.e., no discontinuity of flow occurs, or, more definitely, the velocity of any stream line can not be more than infinitesimally different from the velocity of a stream line infinitesimally distant from it, then it follows that *the boundary of dead water must be a stream line of infinitesimal motion.*

As the preceding sentence is of fundamental importance in the following proof it may be desirable to discuss it more thoroughly. After a short time steady conditions will set in, i.e., at any point in space the successive particles of water pass this point in the same direction and with the same velocity. That steady conditions set in may be seen approximately from inspection, although this is seen to be no longer true as the water leaves the obstruction. As an excellent example of this principle observe the beautifully smooth motion of the water near the bow of a boat sailing on a calm sea; but eddies are usually found at the stern no matter how calm the sea. If it be conceivable let the water at the end of the pipe be bounded by water moving with a finite velocity. Then as water is a *fluid* (i.e., a substance that will yield with time to the smallest shearing stress) and is not a mathe-

matically frictionless fluid, it follows that the bounding stream lines will drag the dead water into motion and so the surface dividing dead water from moving water will be moving inwards—or in other words conditions are not yet steady. Granted that steady conditions set in, then if a path be followed from dead water, keeping always at right angles to the stream lines, the velocity will change from zero to a finite quantity by a gradual variation, or the *boundary of dead water is a stream line of infinitesimal motion.* There will be some particular stream tubes which remote from the pipe have a velocity v (= velocity of stream) and then as they approach the mouth of the pipe gradually spread out, the speed meanwhile decreasing until they skirt the dead water and the speed has become infinitesimal.

If Bernoulli's equation be written out for points A and B, these being points on a stream line which skirts the dead water, we obtain,

$$\frac{v_A^2}{2g} + h_1 + atmos.\ press. = \frac{v_B^2}{2g} + \frac{p}{w} + atmos.\ press. \qquad (2)$$

in which h_1 = depth of point A below the surface.

p = pressure in dead water, which will, of course, be constant at all points in a horizontal plane.

Also, if h is the height to which the water in the tube rises above the level of the water surface, and a is the cross-sectional area of the pipe, then

$$pa = (h_1 + h)wa \qquad (3)$$

Now, v_A is the velocity of the stream, and v_B is infinitesimally small:

Therefore

$$\frac{v_A^2}{2g} + h_1 = \frac{p}{w} = h_1 + h \qquad (4)$$

Hence

$$h = \frac{v^2}{2g} \qquad (5)$$

Note: This proof applies equally well to cases (d), (e) and (f) of Fig. 1, merely an alteration to Fig. 2 being required.

The only part of this proof at which caviling might be legitimate is the part given in italics. If stream-line motion is broken up, if turbulence occurs, then discontinuities may occur plentifully, with the consequent invalidating of the proof. In this case v_B would be greater than zero, from which it follows that the height actually obtained would be less than that given by eq. (5). If the above theory is correct it is quite impossible to obtain a height greater than $\frac{v^2}{2g}$, for the greater the turbulence the greater is v_B and correspondingly smaller is h.

In order to throw some possible light on the above results the writer by the kind permission of Prof. H. C. Sadler made further use of the Naval Tank at the Michigan University to test Pitot tubes with (1) a bell mouth opening, (2) a mouth diverging inwards, (3) a circular disk fastened to the end of the pipe. These types were chosen as representing extreme cases of all possible variations. In each case the results were again within 1.5% of $\frac{v^2}{2g}$ and always below. Case (f) gave $\frac{v^2}{2g}$ as nearly as measurements could be made. This is as would be expected from the proof given, as case (f) is the one least likely to cause turbulence.

The disparity between these results and experiments where a height greater than $\frac{v^2}{2g}$ has been obtained requires explanation.

The Naval Tank is an ideal means of performing these experiments, because no uncertain knowledge of speed exists as does in measuring the quantity of water delivered from a pipe and assuming an accurate knowledge of how the velocity is distributed over a cross-section. Also, the change of velocity due to the introduction of the Pitot tube is avoided in using the tank.

The writer would be extremely interested in a discussion of above, especially from those who have made experiments which are in disagreement with his own, and to facilitate that discussion gives the following summary of his views:

(a) The momentum theory is untenable, as the assumptions made are too wide of the mark.

(b) If stream-line motion exists then the equation $h = \frac{v^2}{2g}$ is rigidly correct both in practice and in theory.

(c) The greater the disturbance to stream-line motion the greater the discrepancy between the experimental head and $\frac{v^2}{2g}$, h always being less than $\frac{v^2}{2g}$.

(d) If the obstruction is small compared to the cross-section of the waterway, e.g., a Pitot tube in a tank or a canal, but not necessarily a Pitot tube in a pipe, then the height both theoretically and practically cannot be greater than $\frac{v^2}{2g}$.

(e) As speed increases (c) becomes more pronounced, though at 10 ft. per second the effect of this was only about 1%.

(f) Experiments where the height differed widely from $\frac{v^2}{2g}$ are probably, in a great many cases, accounted for by inaccurate measurement of the static head by the second leg of the Pitot tube.

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Geared Steam Turbines for ship propulsion were described by Sir Charles Parsons in a paper read before the Institution of Naval Architects in London, on Mar. 13. He stated that the aggregate power of the vessels which are now in service equipped with steam turbines driving the propellers through gearing is about 26,000 hp. These represent cargo steamers, cross-channel steamers and warships. There is under construction at the present time turbine machinery and mechanical gearing for vessels representing an aggregate of over 120,000 hp. Included in this are two vessels of over 20,000 hp. each. The two Channel steamers, plying between Southampton and Havre, which have about 5000 hp. with a speed of about 18 knots, show a fuel economy of about 40%, compared with similar vessels driven by turbines mounted directly on the propeller shaft. A cargo steamer, the "Cairncross," recently built by Messrs. William Doxford, of Sunderland, is equipped with steam turbines with a normal speed of 1700 r.p.m. geared to the propeller shaft with a speed reduction such that the propeller shaft runs at 63 r.p.m. The coal consumption trial of this vessel compared with that of a sister ship equipped with triple-expansion reciprocating engines showed a saving of 15% for the geared turbine installation. An improved method of cutting the teeth of the helical gears has been developed in the Parsons shops and enables the teeth to be finished with a much higher degree of accuracy. The results of this improved tooth-cutting machine is to greatly reduce the vibration and noise in the operation of the gearing.

Another twin-screw geared turbine steamer to run to the Isle of Man has recently been equipped with 8000-hp. engines.

Present Status of the Telephone Industry in the United States

The 1912 report of Theodore M. Vail, president of the American Telephone & Telegraph Co., shows that there are 7,456,000 subscriber stations in 70,000 places of the country (besides some 4,000,000 stations of independent companies). This figure is to be compared with 65,000 post offices, 60,000 railroad stations and 25,000 regular telegraph offices; 2,503,000 of these subscriber stations were operated by local, coöperative, or rural concerns having connection rights with the Bell system. The total length of wire in use by this company was 14,611,000 miles, of which 1,678,000 miles were added during the year 1912. Of this total length some 2,200,000 miles is in toll lines. These figures do not include the wires operated by the connecting companies noted above. The daily average of total telephone conversations reached the figure of 26,310,000, of which 738,000 were toll-line connections. Comparison with similar statistics for Europe shows that all foreign countries combined have only about 40% the telephone traffic of the United States, though showing 3½ times the telegraph traffic and twice the first-class mail traffic.

The total capitalization (including duplications) of the Bell system is $1,294,835,000, of which $568,977,000 is owned and in the treasury of the system. The stocks, bonds and notes outstanding in the hands of the public at the close of the year aggregated $725,900,000. Adding $25,300,000 in current accounts payable, and subtracting $73,400,000 of liquid assets, cash and current accounts receivable, a figure of $677,800,000 is given as the net permanent capital obligation of the whole system outstanding in the hands of the public. Appraisals of the physical property of all the companies of the Bell system have been made by the company's engineers and it is announced that the book cost of Aug. 1, 1912, is about $736,000,000 with a cost of reproduction of $797,000,000, not including anything for intangible assets of any sort.

The steady increase in operating expense per subscriber's station, which has been a striking feature of previous years' operations, was checked in 1912 with a slight improvement over 1911. A small increase in the investment per station has brought this up to $143, which sum, however, is only half the figure for 1895. The net revenue per station was $9.29 in 1912 compared with $23.52 in 1895, due to a 50% decrease of rates and gross revenue following a reduction of nearly 50% in maintenance, depreciation and similar expenses. The percentage on plant investment, required for maintenance and depreciation, is nearly the same throughout this period since investment, maintenance and depreciation have been reduced together. It is contended that the company, by improvements in operation and organization during these years has cut in half those expenses not varying directly with the physical plant and, by improvements in its art and business, has cut in two the investment per subscriber station. The claimed result is that the average net profit is but slightly decreased although the cost to a subscriber is about one-half. Incidentally, the service is more reliable and more comprehensive.

In the engineering department, an important feature of the work has consisted in putting into effect, in the plants and services of the various associated companies about the country, the numerous improvements which have very recently been developed and standardized. The success with devices and methods (Pupin "loading" system) employed for improving transmission and extending the talking distances on the New York-Denver line (see ENGINEERING NEWS, May 25, 1911) has led to a systematic introduction of these improvements throughout the country, so that at the end of 1912 a total of 54,750 miles of heaviest-gage wire had been equipped with these improvements, doubling their transmission efficiency and securing, without expenditure for new wires, "phantom circuits" equivalent to 12,600 miles of heaviest-gage wire.

Places heretofore too remote for intercommunication have been brought together and improvement in the service of distant cities has been made. The plans in hand contemplate extension of four heavy wires from Denver to San Francisco, so as to permit conversation across the continent.

Specifications have been prepared for a new type of cable carrying 900 pairs of wires in the space formerly required for 600 pairs, the latter number being the largest which it has been heretofore feasible to employ. Trouble has been found from vibration from overhead cables resulting in crystallization of the lead alloy of the sheath. An improved (but less expensive alloy) has been successfully developed and this will also save $300,000 per year in first cost of overhead cable construction. Improvements in local operating efficiency, toll-line efficiency, switchboard apparatus, etc., represent savings estimated (conservatively, it is claimed) at over $1,000,000 per year. Although such savings are real and accrue from year to year, it is held difficult or even impossible to trace them in the books of the company, since they are offset by increases in the cost of other materials entering into construction. The effect of such savings, therefore, lies in preventing the total costs from rising as high as they would otherwise.

The president's report concludes with many expressions of the company's willingness to coöperate with government regulating commissions everywhere and particularly with the Interstate Commerce Commission, which recently has been charged with the investigation of the American Telephone & Telegraph Co., leading to the formulation of a national policy towards this utility, which openly aims towards a monopoly of telephone and telegraph service and believes in the benefits arising from such a situation.

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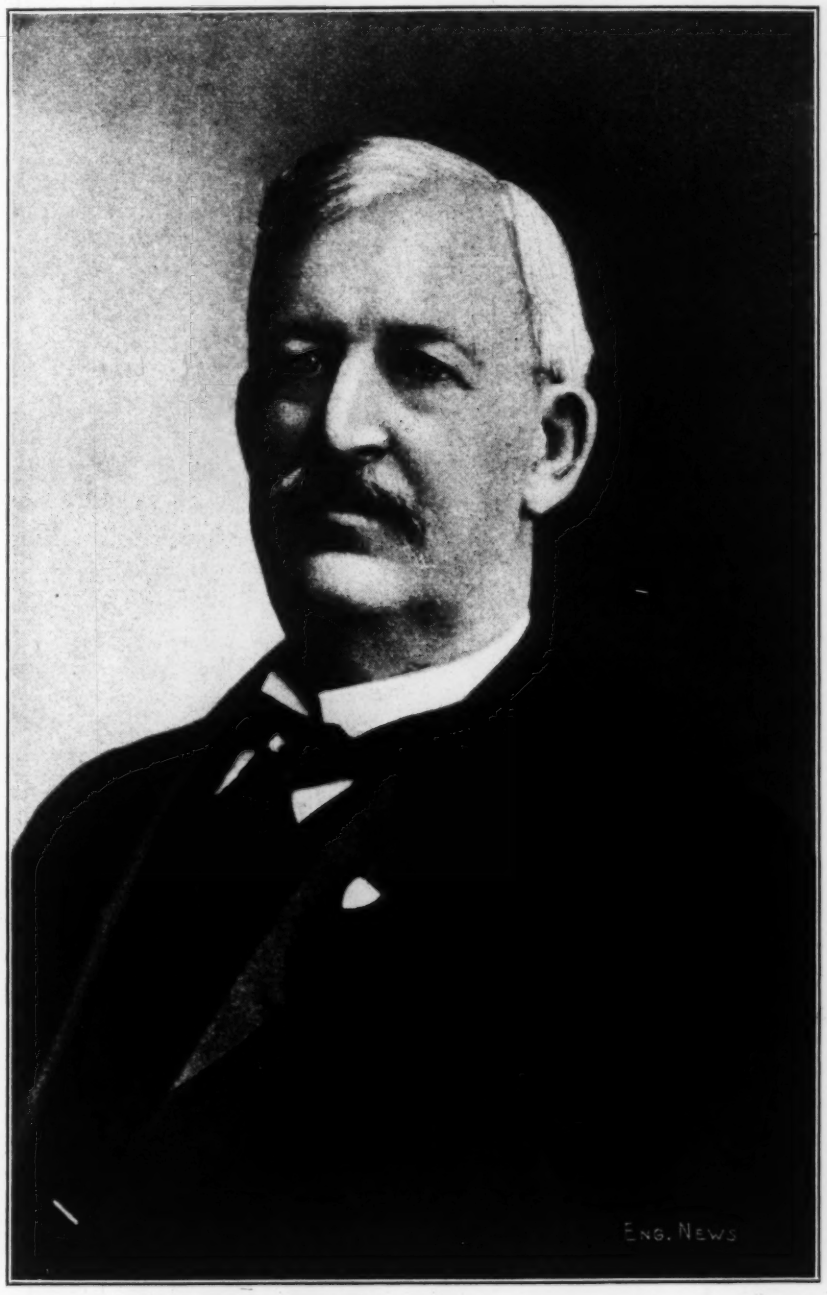
Census Costs and Methods—In the annual report of the Director of the Bureau of the Census for the fiscal year ending June 30, 1912, it is stated that the 13th decennial census (1910) has cost to date $15,171,593, about half of which, or $7,223,385, was expended for field work. The census bureau had much difficulty in getting competent enumerators and the results obtained were in many cases very unsatisfactory. The director states that there is reason to believe that the actual number of inhabitants was ascertained with "approximate accuracy" and that the principal interrogatories on population and agricultural schedules were answered with "a fair degree of accuracy," but he emphasizes the need of trained enumerators and suggests that part of this work in the future be performed by mail carriers. The director states further that there is no way of measuring precisely what the margin of error is in any case; it is sufficient evidence of the need of improved methods that in multitudes of cases interrogatories which are properly applicable are not answered at all, and that statistics on several subjects as tabulated show relationships which are obviously wrong.

James Dix Schuyler*

The death of James Dix Schuyler, last September, closed an admirably developed career. Trained from youth in the rough school of hard work he was, among men of eminence in his profession, a most truly representative Western engineer.



James D. Schuyler

The son of Phillip Church Schuyler and Lucy M. (Dix) Schuyler, James Dix Schuyler was born at Ithaca, N. Y., May 11, 1848. Of distinguished ancestry, his early education at Friends College was representative of the best American traditions and ideals and unquestionably had a powerful influence in the formation of his character.

His years at Friends College, from 1863 to 1868, gave an intellectual foundation eagerly and soundly built upon, although it would seem that his experience there could have included but little of the so called "higher education." Yet James Dix Schuyler was notable as a man of the broadest culture, of scholarly attainments and cultivated taste. His mind was active, orderly and well balanced, with a vast capacity for selective assimilation and sustained effort.

Shortly after leaving school in 1869, Mr. Schuyler joined a railway survey party in Colorado. Those were rough days in the West, and railway preliminary surveys, and even location surveys, were matters of considerable hazard. The Indians were constantly giving trouble, and the youngster from the East was likely to get a good deal of experience not of a strictly professional character. That it had its value, however, is indicated by the remark credited to the late Howard Schuyler, elder brother of James Dix Schuyler, that he owed his position as Chief Engineer to the fact that he could run a railway survey and fight Indians at the same time.*

From the quiet old college Mr. Schuyler stepped directly into the stern and picturesque life of the West. Many times during his early experiences in Kansas and Colorado on the location surveys for the Kansas Pacific and with the Denver & Rio Grande Rys., the field parties were compelled to take cover from the Indians; sometimes the instruments were abandoned in the urgency of retreat, so sudden would be the alarm, and on one occasion, in the thick of a hot fight, Mr. Schuyler was shot through the leg.

All his life alert to the call of wild places, those first years of young manhood, filled as they were with hardship, danger, and engrossing work, bound him to the West, and he was a part of the West to the end.

From 1873 on Mr. Schuyler lived in California. There his first professional work was as Division Engineer of the North Pacific Coast R.R., from Ross Valley to San Rafael. In 1874 he was appointed Chief Engineer of the Stockton & Ione R.R., but when this project failed financially, he took up, for the time being, work as a newspaper writer on the Stockton *Independent*.

It is probable that with this experience began the development of a literary style that was always admirable and highly characteristic of the man. Without pedantry, he was a master of English, and in his personal correspondence there was always an inimitable ease and charm, so truly his own that it expressed the very essence of his personality. Even his professional papers and technical articles exhibited this same fluent and

*Contributed by request by George Sydney Binckley, Consulting Engineer, Los Angeles, Calif.

*Those who have read a letter narrating one of Howard Schuyler's adventures, published in our issue of July 20, 1911, will be ready to believe this.—Ed.

graphic use of language. He was one of the few who speak and write their language in the same terms. This capacity for expression was beyond doubt of great importance to Mr. Schuyler in his broad engineering practice, and his lucid and pleasing style was an important factor in the presentation of his conclusions as embodied in professional reports.

In 1878 Mr. Schuyler was appointed Assistant State Engineer of California; and in this capacity he was placed in charge of the irrigation investigations then being conducted by the State Engineering Department. These investigations, made during the early period of irrigation development in the West, covered a large part of the great central valley of California.

During the four years that he was in charge of this work, as a man of broad and comprehensive imagination, he could not fail to grasp the enormous future importance of irrigation. Although from 1882 to 1884 he was Chief Engineer and Superintendent of the Sinaloa & Durango R.R. in Mexico, he must already nave felt his life work to lie in the field of hydraulic engineering, and from that time forward he departed but little from his chosen specialty.

Following a very unprofitable venture as contractor for a section of the seawall on the water front of San Francisco in 1884, he was placed in charge of the completion of the Sweetwater dam*, near San Diego, Calif.

The history of this interesting work is well known, especially to Western engineers; but it is worth while to recall that the original design of the dam, as projected, was by F. E. Brown, who designed and supervised the construction of the famous Bear Valley dam†, that slender granite arch which has defied time, water, ice and critics for a good many years, and still stands although (according to some) a mathematical impossibility.

Rejecting as too radical the original plans of Mr. Brown, Mr. Schuyler designed for the Sweetwater site an arched dam with what was, at that time, a very bold cross-section, by giving (in the face of the disapproval of some very learned authorities) due weight to the element of support provided by the arched form of the structure. This takes little courage nowadays, but at the time when the Sweetwater dam was built precedents for such a design were few, and the weight of authoritative disapproval was heavy.

Although by no means comparable even in boldness with some of his later engineering work, Mr. Schuyler found in the Sweetwater dam his opportunity. Here was a chance to demonstrate his courage and faith in himself, and he made good use of it. It is interesting to consider that although he himself could never have doubted for an instant the perfect security of this dam, the fact that it stood when the reservoir filled made his reputation in California. It is still more curious that when through insufficient spillway capacity the dam was overtopped by an unprecedented flood that poured over the entire crest and thundered on the footings 90 ft. below, he received additional credit because the dam stood, instead of the natural, even though unmerited, criticism of the insufficiency of the spillway.

After having undergone several changes of original plan as to height, the Sweetwater dam was finished in 1888. From that time Mr. Schuyler's advance in his profession was rapid. By curious fitness, the last important work carried out under his personal direction was the recent extension to the Sweetwater dam,* in itself an unusual and interesting problem; so this, his first really great engineering work was also, in its final extension, his last—with it his career as a hydraulic engineer began and ended.

Much of Mr. Schuyler's work was in the West and Southwest. As Consulting Engineer to the Lake Hemet Water Co., he designed and supervised the construction of the Lake Hemet dam, a high masonry structure. Two concrete dams of his design form distributing reservoirs for the city of Portland, Ore., and he did important work in connection with the water-works systems of Denver, Colo., Ogden, Utah, and many other cities in the West and Southwest. He was retained on the Bear River Canal in Utah, and designed the extensive works comprising the Twin Falls irrigation development in Idaho. The Zuñi dam† in New Mexico, the Lake Frances dam in California and the Terrace dam in Colorado, are representative of his activity in this country.

His engagements as an advisor took him to many remote places, and much of his most important work was abroad. He was called to Hawaii as Consulting Engineer to the Territorial Government to report on the Nuuanu dam, to Brazil to design the great Santo Amaro dam, and to Mexico to design a system of reservoirs which included that formed by the Necaxa dam‡, greatest of all the hydraulic-fill type. He was called to Japan to pass upon the feasibility of a proposed storage reservoir for a power project involving the construction of a dam 320 ft. high.

The hardships of this Japanese trip left him with a broken constitution. The dam site to be examined was difficult of access, and a natural pride in his remarkable strength led him to attempt exertions too great for a man of his years. After an unusually hard day, climbing the rain-drenched trails of remote Japanese mountains, he suffered a sudden and alarming illness, and had to be taken at once to the coast.

A wild trip in a flimsy Japanese skiff, through the rapids of roaring mountain rivers, brought him at last into touch with civilization, but even under the best of care his recovery was slow and never complete.

It was characteristic of the cheerful optimism that was part of the man, that when lying practically helpless in the skiff, he kept his camera busy, and that frantic rush through tumbling white waters was quite completely recorded; and when he could do nothing else, he studied with keen interest the twisting, flexible, ribless boat that slid and leaped under him as it shot toward the coast.

To merely enumerate the important works in connection with which Mr. Schuyler was retained would make a long list. Bold and original, his conclusions were little influenced by precedents merely as such; yet he had a goodly share of caution, and it would be hard to find in his record an example of rashness.

His reports on irrigation or water-supply projects are numberless and bear witness to an indefatigable industry and care in the collection and weighing of data and an orderliness of arrangement that was a life-long habit. Possessing one of the best engineering libraries in the

*See Eng. News, Oct. 27, 1888, Aug. 15, 1895, Mar. 30, 1911.
†See Eng. News, Apr. 7, 1888, June 23, 1888, Nov. 23, 1889, Nov. 30, 1889.

*Eng. News, Mar. 30, 1911.
†See Eng. News, Dec. 2, 1909.
‡See Eng. News, July 15, 1909.

West, he made liberal use of its resources, and his exceptional acquaintance with the literature of his profession was of very substantial benefit to his clients.

In his later years, Mr. Schuyler was the recipient of high honors. A member of the American Society of Civil Engineers, he served one term as Vice-President, and was twice awarded the Thomas Fitch Rowland Prize. He was a member of the Institution of Civil Engineers of London, and of various other societies and clubs.

He was retained as one of the board of three consulting engineers on the Los Angeles Aqueduct, and suggested the changed location and plan by which 10% of distance and 12 to 15% of cost were saved. He was one of the Board of Consulting Engineers sent by President Roosevelt to Panama in 1909 to report on the Panama Canal and the Gatun dam. His book on reservoirs is as well known and as highly appreciated abroad as in this country, and his recognition as an engineering authority is international.

A critical estimate of Mr. Schuyler's work as an engineer must give high place to his development of the principles and methods of hydraulic-fill dam construction. No more radical, or indeed revolutionary, advance in the art of impounding water has been made in recent times. Mr. Schuyler, although not the originator of the hydraulic-fill dam, certainly stands alone in reducing construction methods to a system and applying them to an extensive practice.

The little dam, built in 1894, at Tyler, Tex., the first of the hydraulic-fill type, was the beginning of a long list. Such work as the Santo Amaro dam, the Necaxa dam, the Terrace dam, the Gatun dam and others too many to even enumerate demonstrate the utility of this method of construction. Few important dams of this type were undertaken during Mr. Schuyler's lifetime without his advice being sought, and little advance over the methods developed by him has been made by other engineers.

His almost intuitive perception of the vast importance of this simple and natural method of constructing a watertight embankment, the courage with which he employed it on great works, and the indefatigable industry with which he constantly broadened the scope of its application and perfected the details of its technique, are all worthy of high admiration.

Tactful and considerate always in his rare criticism of others, he was not spared a very free and at times almost savage criticism of his own work during the earlier years of hydraulic-fill development. Yet the accident to the Crane Valley dam, by which some of the core material was lost, was practically the only failure of moment in the history of this class of construction until that at the Necaxa dam; and this latter was a construction accident purely. Himself wholly blameless in this matter, Mr. Schuyler felt very keenly the position it placed him in, yet he forebore to avail himself of legitimate opportunity to place the blame for this disastrous accident where it properly belonged. Sensitive as he was to injustice, his restraint in this matter must have been very difficult to maintain.

Few engineers unfamiliar with the West realize to what an extent the unusual conditions encountered there have controlled the development of its engineering practice and standards. Several generations of engineers, in the professional sense, have carried on the work of building one of the great masonry dams of the East; but the Western engineer must often take up his problem with a mind free from the trammels of custom or even precedent, and generally he must deal with its elements, great and small, under the strictest limits of cost and time. So it comes that much bold work has been done, and many untried methods have been put to the test. Prompt and original solution of problems is the rule rather than the exception. Results must be accomplished under the most severely adverse conditions and wholly unexpected obstacles overcome as they arise. Hence few of the earlier engineering works in the West leave nothing to regret in design or execution, even while reflecting high credit upon the bold and able men who directed them.

Mr. Schuyler rarely enjoyed the luxury of a perfectly free hand and unlimited funds for the embodiment of his best ideals in practice; yet even where the exigencies of economical design and construction were paramount, he had little or nothing to reproach himself with, and his record of uniform success was enviable.

Trained in a hard school of economic limitations, an optimism which sometimes led him to under-estimate the cost of work, was accompanied by a caution and foresight that guarded him from the pitfall of unsafe design. Structural necessities he never neglected, but the strictly utilitarian character of most engineering work led him, unconsciously, to minimize the importance of the monumental or architectural features of works of such importance as to justify broader treatment in the æsthetic aspect, treatment such as would be given structures of equal importance in Europe. This was by no means due to lack of artistic perception, but only to a conscientious regard for the interests of his clients.

Mr. Schuyler's valuable work on reservoirs is not more remarkable for its wide range and practical treatment and comment than for the total absence of any theoretical or mathematical discussion whatever. In this characteristic it is comparable with Ewbanks' old treatise on hydraulics—long out of print, but still of great value.

It may perhaps be regretted that a tact and consideration habitual with Mr. Schuyler should have so restrained his criticism that we are not given the full benefit of his own knowledge in studying certain failures. In his book on reservoirs he has reduced adverse criticism almost too far for full justice to his reader, and has thus denied the student assistance that would have been of great value. Certain instructive facts have been, out of a kindly personal charity, suppressed or so lightly touched that they do not carry the lesson they should. Even where defective work resulting in failure is shown in pitiless photographs, his own comment avoids censure, although at times the temptation to frank and merited condemnation must have been very strong.

To make an unbiased estimate of James Dix Schuyler as a man is impossible for one who knew him for many years as friend, traveling companion, and professional associate. His faults were few and very human—little faults to smile at, for they harmed no one except himself, and hurt him but little. Tact and culture were coupled with a charm of personality that disarmed those prepared to be his enemies, and bound his friends to him for life.

A tall and powerful man, his strong features suggested his Dutch ancestry, and the fine head, firm jaw, and aquiline nose made him a man of notable presence. Genial, of keen but kindly wit and lively humor, he was

a delightful companion, whether in the home, or on the trail in surroundings of hardship and discomfort. Kindly and placid, unhurried of speech, he was a man of great intellectual energy and a tremendous worker. Leisure found little place in his life, yet in the midst of his exacting professional work he found time for broad and varied reading, and his interests were of wide scope.

Mr. Schuyler was married in July, 1889, to Mrs. Mary Ingalls Tulliper of San Diego, who survives him. He lived in Los Angeles and Ocean Park for many of the later years of his life, and he had made final arrangements for at least partial retirement from active practice only a short time before his death.

Seemingly well on the way to recovery from an exhausting illness of months, Mr. Schuyler passed away at his home in Ocean Park, Sept. 13, 1912. A sudden relapse that even his indomitable courgea could not conquer followed the excitement incident to the great fire in Ocean Park early in September; and after as gallant a fight as a man could make, the end came. Ripe in years, James Dix Schuyler was still in his intellectual prime, and his loss was of moment to his profession. But to his friends and associates it was more, for it falls to the lot of few to know two such men.

Frank Soule*

Frank Soulé, Emeritus Professor of Civil Engineering at the University of California, whose death was briefly noted in our issue of Feb. 27, was born at Woodville, Miss, in 1845. He came of New England ancestry, tracing his lineage direct to John Alden and Priscilla Mullins of the "Mayflower's" company. Frank Soulé's father as early as 1861 was a settler in California, where later he became well known as a journalist and as one of the authors of the "Annals of San Francisco."

Frank Soulé attended the U. S. Military Academy at West Point where he was graduated in 1866 and was assigned to duty as Assistant Ordnance Officer. In 1867 he was ordered to West Point as Instructor in Ordnance and Gunnery and later was Assistant Professor of Mathematics.

In 1869 he resigned from the Army to join the faculty of the University of California, as Assistant Professor of Mathematics. When, in 1872, the Board of Regents established the chair of Civil Engineering they appointed Prof. Soulé to that chair and also added the teaching of astronomy to his responsibilities.

The records of the University of California for the period ending 1880 show how prominent was the work of Prof. Soulé in those early days. He not only gave his time to mathematics, astronomy and engineering but was the father of the Military Department. In 1886 the Students' Astronomical Observatory was designed and built by him with special state appropriations. In the next ten years, under his direction and with the coöperation of the late Prof. George Davidson many important astronomical observations were made and measurements performed. He inaugurated the Weather Bureau Record, which later was distributed by the Department of Astronomy and now is reported by the Department of Geography.

In 1890 the exacting demands of the rapidly growing Civil Engineering College forced Prof. Soulé to relinquish his interests in astronomical work. In the early '90's, after a visit to the prominent Eastern and European technical schools, he built and equipped a testing laboratory which from a modest beginning has grown into the present Civil Engineering Department Experiment Station.

Prof. Soulé continued in the active service of the University as Professor of Civil Engineering and as Dean of the College of Civil Engineering until the summer of 1907, a period of 38 years. In 1907 he spent his sabbatical year in foreign travel, visiting Egypt and most of the countries of Europe. On his return to California in 1908 he was retired on the Carnegie Foundation, becoming Professor Emeritus of Civil Engineering. Though his active work had ceased, he still retained a deep interest in the welfare of the college which he had organized. It is given to few men to serve an institution for a span of 44 years and in such varied capacities.

*Prepared by request by C. Derleth, Jr., Dean of the College of Civil Engineering, University of California.

He was a man of multifarious tasks and of many-sided usefulness. No one had closer touch with the students than he, both by virtue of his one-time office as Commandant of the Cadets and by his own interest in their welfare. He was a military man in bearing and in thought. He believed in discipline and in authority. He laid upon himself the heavy hand of self-control. He was always kind and thoughtful of others, and above all things a man of unfailing courtesy.

During the last ten years of his service it was his deserved pleasure to witness the great expansion of the Engineering Colleges of the University. From 1870 to 1900 his school, like the city of San Francisco, developed slowly. It was about 1895 that the University began to grow with leaps and bounds. In his immediate Civil Engineering College there was established a department of irrigation. Courses related to forestry and public health were planned. The relations between agriculture and engineering were defined. Sanitary studies began to form a vital part of the curriculum. Instructors in municipal and sanitary engineering were called upon to coöperate with the Medical Department, with bacteriology, animal industry and hygiene.

The professors of sanitation and irrigation are now concerned with the practical Agricultural School at Davis. The structural departments are associated with the Department of Architecture no less than with that of Engineering. The Testing Laboratory is in touch with state problems. Surveying courses lead to instruction in geodesy, through which channel the students are brought in contact with the Department of Astronomy. Through railroad work they deal with economics; by the writing of contracts and specifications they lean upon the Law Department; in the design of buildings they become interested in fireproof construction, fire protection and prevention, and study in the Departments of Economics and Insurance. All these relationships are daily bringing civil engineering into closer sympathy and bond with the whole University.

Prof. Soulé lived to see his University start from the humblest beginning and grow into one of the most powerful institutions in the country; a University which in 1913 in number of students is second in the United States. Moreover, as an instructor in engineering, he lived through eventful years in the development of engineering education, from the pioneer days of instruction in applied science to the present technical school with all its special branches.

Prof. Soulé was always interested in the public affairs of the community in which he lived. Whatever movement looking to a betterment in politics and community life had arisen in California in recent years, that movement found in him a ready helper. In earlier days his active interest was in Oakland, later in Berkeley, where recently he was a member of the committee which framed the now famous city charter.

Since Prof. Soulé gave much of his energy and life to community interests and problems, it was only natural that he should be associated with many societies. He was a member of the Association of Graduates of the U. S. Military Academy; a member of the Loyal Legion, U. S. A.; Colonel in the California National Guard; life member of the Geographical Society of the Pacific; member of the Society of Mayflower Descendants; member of the American Society of Civil Engineers; life member of the Society of California Pioneers. For many years he was a member of the Athenean Club of Oakland, of the University Club and of the Bohemian Club of San Francisco.

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The Hearing on the Bill to License Engineers in New York

A hearing on Bill No. 1126, introduced into the New York assembly by Mr. Larrimer and entitled "An Act to Amend the Education Law in Relation to Licensing of Civil Engineers and Surveyors," was held by the Assembly Committee on Education, Hon. Ralph R. McKee, chairman, on Apr. 1, 1913.

State Engineer Bensel said he was in favor of licensing engineers but opposed to the present bill. He showed that the definition of Civil Engineer was improper and suggested that the requirements for the adoption of this title be fixed by the American Society of Civil Engineers. In answer to a question by Mr. Larrimer he stated that he and several members of the American Society of Civil Engineers had promised, at the time of the consideration of the McGrath Bill and the Hoff Bill two years ago, that the Society would draw a bill for this purpose. This he regretted had not been done.

R. D. Mershon, President of the American Institute of Electrical Engineers, spoke against the bill as a representative of the Institute. Engineers, from the nature of their occupation, are constantly moving from one place to another and this bill would require eminent engineers to submit to examination when called in consultation from another state. He stated that no notice of the bill had been sent to his society.

Arthur M. Greene, Jr., spoke for the American Society of Mechanical Engineers, and for the Society of Engineers of Eastern New York. The Executive Committee of the Council of the American Society of Mechanical Engineers believes the bill to be poorly drawn and pernicious in its effects. They authorized the statement, however, that the Society would join with other interested organizations in preparing a bill for the next legislature provided the present bill be tabled. The Society of Engineers of Eastern New York is opposed to the bill as shown by a letter ballot, 171 members voted against the bill and 17 in favor. Mr. Greene pointed out defects in the bill in the definition of Civil Engineer, in the matter of compensation of the examiners and in giving the fines collected for the violation of the act to any incorporated society which should make the complaint.

Dr. Whitney, in charge of the research laboratory of the General Electric Co., spoke against the bill as affecting the Chemical Engineer.

Mr. Betts, of the Board of Water Supply of the City of New York, presented a brief against the bill.

F. J. Molitor, representing the Society of Consulting Engineers, spoke of the hardships this bill would work on the engineers of other states. He showed how the engineer was constantly sent from one state to another and even to other countries. Two states were mentioned by him as having license laws, Florida and Louisiana. These laws were very simple and provided principally for the payment of ten dollars per year. Several Western states licensed land surveyors and irrigation engineers. He thought it would be better to license designs than the engineer. He commended the excellent work of the correspondence schools, but did not believe that they should be classed with the other institutions of learning.

Prof. O. H. Landreth spoke against the bill for the Engineering School of Union College and for the American Society of Mechanical Engineers. The points he made were as follows: There was no call for the bill; the bill is being pushed by a small organization and not by engineers in general; at present the profession and public are protected by civil service examination, which differentiates between the various classes of engineers and by the necessity for state approval of plans of public works; if these two methods were strengthened, all that is necessary would be accomplished; the requirements for membership in the national societies and graduation from our technical schools are sufficient protection. Results will not be made better by the bill; mistakes will be the same. He clearly showed the difference between the lawyer and the doctor and the engineer who is usually called in for work which demands the expenditure of much money so that care is exercised in selecting him.

Mr. Sprague, Past-President of the A. I. E. E., and Vice-President of the Society of Consulting Engineers, read letters from Alfred Noble and W. H. Burr, stating that they were opposed to this bill, although favoring the licensing of engineers. Mr. Sprague emphasized the inadequate definition of

a civil engineer given in the bill, and showed how for three years any man who had practiced, no matter what his ability, could demand a license. He was opposed to the licensing of engineers, but said he would be willing to aid in drafting a suitable bill should there be any real demand for such legislation.

Walter G. Eliot, J. H. Weinberger, Mr. Zartman, L. Schonmaker and Mr. Seeley were present to speak in favor of the bill.

Mr. Eliot stated that Canada required licenses and a number of states had bills now pending before their legislatures. He stated that most of the National Societies of Engineers were afraid to submit the question of licenses to their members because most of them would be in favor of it. This statement was questioned by representatives of the societies.

J. H. Weinberger merely stated that he was in favor of the licensing of engineers and of the bill. Mr. Zartman, of the Park Commission, was in favor of the bill. L. Schonmaker, of the Topographical Department, stated that it was the sentiment of the men in his office that the bill should be passed and that he personally thought the arguments against the bill were defective.

Mr. Seeley, of the Department of Sewers of New York, saw no specific objections to the bill. He referred to certain clauses to answer objections to the bill, but did not read them. He attempted to show how the bill would protect contractors and how defective sewer systems would not be designed if the bill were in operation. The examples quoted, however, could occur under the bill as well as without it. There was no argument presented by those favoring the bill demonstrating any advantage to accrue from it.

Most of those appearing against the bill were opposed to any form of license for engineers, but they promised that they would aid in drawing a proper bill if requested to do so by the Committee on Education or any member of the committee. Many pointed out the saner method of professional service as a prerequisite for the license. The present bill, except for the dates in it, is reported by those who have compared it to be the same as the McGrath bill, introduced in the legislature of 1911.

NOTES FROM THE ENGINEERING SCHOOLS

LEHIGH UNIVERSITY—Announcement has recently been made of a gift from Charles L. Taylor, of Pittsburgh, former partner of Andrew Carnegie, president of the Carnegie Hero Fund, and vice-chairman of the U. S. Steel and Carnegie Pension Fund, for a large gymnasium and stadium. Compulsory athletics for all students has been in force at Lehigh for over a year, and the new equipment is intended to afford complete facilities for the work thus assumed.

It is also announced that the late John Fritz has left his residuary estate, amounting to about $150,000, to Lehigh primarily as an endowment fund for the maintenance of the John Fritz engineering and testing laboratory, which was given in 1910 and the construction and equipment of which was personally supervised by Mr. Fritz.

UNIVERSITY OF PITTSBURGH—It is announced that Andrew W. and Richard B. Mellon have founded and endowed an "Institute of Industrial Research and School of Specific Industries" for this university, it being a development of the Industrial Research Laboratory which was organized some three years ago and has since been housed in a temporary two-story frame structure. The new school is dedicated in general to "the application of contemporary science to industrial processes," and in particular will provide opportunities for the training of men (1) for high industrial positions, (2) for advanced chemical engineering and (3) for applying industrial chemistry to specific industries.

The founders have provided for the erection of a suitable building to cost $150,000, with equipment and initial supplies to cost $60,000, and with a scientific library to cost $20,000. The architect will be Henry Hornbostel, of Pittsburgh. A further sum, not to exceed $200,000, has been provided for the first five years' maintenance, to assure pursuit of important researches and to permit immediate entrance to a wide field of activity. After five years it is expected that the institution will be self-sustaining.

Robert Kennedy Duncan, Director of the Industrial Research Laboratory, has been chosen first Director of the new Institute.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—President Maclaurin has announced a gift of $25,000 (in annual instalments of $5,000) from the American Telephone & Telegraph Co. to be devoted to the cataloging, maintenance, and replenishing of the Institute's electrical engineering library.

William Welles Bosworth has been selected as architect for the new group of buildings which will house the Massachusetts Institute of Technology at Cambridge. With him will be associated James Knox Taylor, former supervising architect of the U. S. Treasury, and now head of the Department of Architecture at the Institute.

A new method of teaching mechanical drawing is being is being tried in this Institute. The students are first taught to make a drawing in perspective or in isometric projection. They are then given an orthographic projection of some simple piece and required to redraw it in perspective or in isometric projection. After that, a working drawing of some fairly complicated casting is redrawn in perspective. This course is followed in the belief that a student who has made a number of such drawings is believed to visualize the drawing more quickly so that any print will be easily recognized as something more than a series of lines in one plane.

A summer course in Qualitative Analysis is to be given by the Department of Chemistry and Chemical Engineering for five weeks. This corresponds to the summer school of the other engineering departments and the work will be mainly in the laboratory, with little outside study. The time, for the course in chemistry, will be devoted to additional analytical chemistry and the development of existing subjects. For the course in chemical engineering, the time will be allotted mainly to work in the division of mechanic arts, in drawing, and in the problems of chemical engineering.

Work done by the Department of Electrical Engineering in connection with the Edison Electric Illuminating Co., of Boston, in the investigation of the economic field for electric commercial vehicles, and in a similar investigation for the New York, New Haven & Hartford and Boston & Maine R.R. companies into the adequacy of facilities for handling inbound and outbound freight at the Boston terminals, has led to the recommendation that, in the near future, there should be established a department of business engineering in which students will be trained to apply engineering methods to economic problems that arise in various lines of business. The instructing staff of this department at first would be formed by representatives from the various other engineering departments, and they would devote such portions of their time to this work as necessity required.

EDITORIALS

Sane Advice on Flood Control

It is important that the engineering profession should hold sound ideas on the important questions of river regulation and flood control which are at this time attracting such wide attention. We earnestly commend to our readers' attention, therefore, the admirable address delivered before the National Drainage Congress last week by Col. C. McD. Townsend, President of the Mississippi River Commission, which is printed elsewhere in this issue. Col. Townsend applies the inexorable logic of figures in discussing the possibilities of forest planting and reservoir construction as a means of controlling floods.

The newspapers nowadays are teeming with talk from men in high places to the effect that floods must be controlled by reservoirs at the headwaters of the rivers; but Col. Townsend shows by quoting actual records that had there been a reservoir at Pittsburgh big enough to take the entire flow of the Allegheny and Monongahela, another at St. Paul big enough to take the entire flow of the upper Mississippi, and a third at St. Joseph taking the entire flow of the Missouri, the height of the flood at Cairo during the first week in April would have been lessened *by only six inches.*

Probably the advocates of reservoirs would fall back upon the proposal that reservoirs should also have been built on the headwaters of the Wabash and Miami and Scioto and Muskingum Rivers in Ohio. It is one thing to talk about such a project, however, and quite another thing to find practicable reservoir sites on the headwaters of those streams where any considerable part of the flood could have been stored. The fact may as well be squarely faced that when a rainfall of three inches to nine inches or more comes down on a drainage area within a short time, it is idle to talk of storing it by any means within the power of feeble man to construct.

We have said that it is important to the public welfare that the engineering profession should hold intelligent ideas upon this subject. It is important because it is "a little leaven that leavens the whole lump." If engineers everywhere hold sound ideas on this subject, they can wield an influence in the guiding of public opinion. As we have pointed out in recent issues and as the pages of every daily paper and of the popular weekly journals bear testimony, the public has the vaguest ideas concerning the possibilities of flood control. Wise leadership may direct present public agitation so that useful legislation will result, perhaps creating a National Department of Public Works, as recommended by the Drainage Congress last week, or a Federal organization for river control.

In urging such an organization, however, we would not be by any means understood as advocating that the expense for local works for river regulation should be borne by the Federal government. As Col. Townsend well points out, such a plan would start a new competition among Congressmen. Each would aim to get the largest possible appropriation for his district, and, most unfortunate of all, the voters of his district would judge his usefulness as a legislator by this standard.

⁂

An Admirable Opportunity to Experiment in State Railway Ownership

We have several times referred in these columns to the agitation in New England over the abandonment by the Grand Trunk Railway Co. of its projected extension to Providence, R. I. The Grand Trunk Co. has declared that its abandonment of the work was due to its inability to raise money for completing the work, and it offered recently to go ahead and complete the line provided the State of Rhode Island would guarantee payment of the bonds to be issued for the construction. The terms of the guarantee were to be such that the State would not be obligated unless the road itself failed to earn the interest on its bonds and unless in the second place the Central Vermont Ry. Co., which was to make the first guarantee of the bond, was unable to meet its obligations.

The State of Rhode Island, however, rejected this offer. It was ready enough to assail the Grand Trunk Co. and all its officials and attack them with civil and criminal proceedings because of their failure to finish the Providence extension; but it was unwilling to risk to any extent whatever its own credit, even to becoming a second guarantor on the bonds for the work, in order that the line might be completed.

President Chamberlain, of the Grand Trunk Co., has therefore come back with a new offer to the State of Rhode Island. New England has been seething with talk concerning the desirability of government ownership of railways during the last six months. President Chamberlain, therefore, offers to the State of Rhode Island a chance to embark on State railway ownership under most favorable terms.

He offers to present to the State as a free gift the Southern New England R.R. now partially completed between Palmer, Mass., and Providence, R. I., and on which nearly two and a half million dollars have already been expended. The only condition attached to the gift is that the State shall complete the construction work so that the road may be put in operation.

If the State desires to go into the business of railway operation as well as railway ownership, President Chamberlain offers to grant to the trains which the State may operate over this road, running rights on reasonable terms over the New London Northern R.R. from Palmer to Brattleboro, Vt., so as to make the line sufficiently long to constitute an economical operating division. He will also make a traffic agreement between the Central Vermont and the State-owned railroad whereby through rates may be divided between the two roads on a mileage basis with a reasonable additional allowance for terminal expenses.

If, however, the State does not wish to engage in the business of railway operation, the Central Vermont Ry. Co. will lease the State-owned railroad for a rental equivalent to 5% interest on the actual cost to the State of completing the whole line.

It is difficult to see how anything could be fairer than this last-named proposition. If the city of Providence and the State of Rhode Island are really desirous of having this new railway outlet completed, they have only to find the money for the work. They are assured in advance of a 5% return on the money, which would pay the interest on State bonds at 4% issued for the cost of construction with 1% per annum additional for a sinking fund which would eventually retire the bonds.

The only risk attendant upon this financial transaction is the risk that the present wave of public regulation and labor union control of railway operations will destroy the revenue earning power of railways generally. If and when this comes to pass, the public as a whole will have to suffer; and if the taxpayers of the State feel that they have a financial stake in continued railway solvency, it may lead them to take a saner view of the railway situation.

If, however, the State is not willing to accept as a free gift the partially completed railway under either of the plans named above and is not willing, either, to back with its own credit the railway company in obtaining capital to complete the line, then President Chamberlain says definitely that the road will be abandoned entirely about the middle of April.

It will be of interest to see what reply Rhode Island will make to this latest offer. We earnestly hope that the State will take advantage of the Grand Trunk Company's offer and will go ahead and complete the road. The experiment of State railway ownership could hardly be tried under more favorable auspices, and with all the talk of State railway ownership and management now current, it is well worth while to have the experiment actually tried by some State on a moderate scale.

❋

Why Not Apply Engineering Methods of Scientific Analysis to Engineer's License Legislation?

We have given much space in this and preceding issues of ENGINEERING NEWS to letters discussing the proposed legislation requiring engineers to be examined and licensed. As our readers will notice, while we have in our editorial columns opposed such legislation, we have given space to letters from engineers who favor it. We have even broken the usual rule which obtains in practically all publications and have printed some communications which came to us anonymously but which were apparently sent in good faith.

In our editorial discussion of this subject, it should be distinctly understood that we do not in any way question the sincerity of those members of the profession who believe in and favor the enactment of licensing laws. From correspondence and conversations with a number of these men, it is evident to us that they are filled with an honest desire to what they believe will be of benefit to the profession.

It ought to be clearly recognized, however, that good intentions cannot save a work from failure in law or in morals any more than they can in engineering. What seems to be the weak point in the argument of those who favor engineers' license laws is the lack of any logical demonstration as to just how these laws are going to produce any tangible beneficial results to the engineering profession as a whole.

When a competent engineer undertakes the design of a machine or a structure, it is his business to foresee the result which is going to be produced. Therein lies the difference between the competent engineer and the man who works by rule of thumb. The engineer, for example, plans out in advance where each detail part is to be placed and how it is to be operated. He builds the machine first in his head, and then on paper before it assumes material form at all. The old rule-of-thumb designer who attempted to build a machine without any preliminary detailed drawings, very often found when he came to put his work together that one part interfered with another part, and the machine was inoperative.

The engineering profession has before it the proposition to create a piece of legislation which will restrict the practice of engineering. Surely, before the profession estableshes this machine or permits it to be established, a very careful investigation should be made to see how the machine is going to work.

One of the stock arguments of those who are working to obtain the enactment of state license legislation is that since doctors and lawyers require a state license to practice their profession, the same rule should apply to engineers. Those who use this argument would do well to take a further step, however, and inquire whether the state regulation of these professions of law and medicine has prevented their becoming overcrowded. They will find on investigation that in both law and medicine the surplus of unemployed is much greater than it is in engineering.

We are all of us too prone in considering matters of this sort to give attention to the successful and prominent men whom we know about rather than to the many who fail and of whom we hear very little. The famous surgeon with his enormous fees and the corporation lawyer with his high repute are made known to everyone through the public prints, but we hear little concerning the hundreds of medical students who, after spending years of time and thousands of dollars on their education, fail to secure practice enough for a living. The facts and statistics have been spread abroad, however, by the Carnegie foundation and it is logical to conclude that if state examinations and licenses have not prevented the enormous over-crowding of the legal and medical professions they will not help the overcrowding of the engineering profession.

It is easy to see that the underlying idea of those who are promoting this license legislation, in New York at least, is to prevent anyone engaging in engineering practice unless he has graduated from an enginering school. At the start, of course, in order to secure the enactment of the law, they are obliged to open the gates very wide, but the proposition is that later on no one but graduates shall be eligible for a license.

Suppose now this ideal was realized, would this cut down the supply of men looking for positions sufficiently to cause a radical increase in salaries through the operation of the law of supply and demand? To those who think so we suggest a perusal of the catalogs of a dozen

or a score of the prominent engineering schools and of the statistics showing the enormous number of engineering graduates which are turned out yearly now in comparison with the mere handfuls of a dozen years or so ago.

Suppose, however, that the hopes of these men were realized, so that it would be possible for the average graduate of an engineering school to get a position promptly at graduation, paying, say, $60 to $80 per month, with assured promotion after two to four years' experience to a position paying $150 to $250 per month. Suppose that by the passage of some sort of engineers' license legislation, it was possible to establish such conditions. How long would such conditions last? The answer is easy. They would last only long enough to enable a new and enlarged crop of graduates to come in from the engineering schools sufficient in number to bring down the compensation by the inexorable law of supply and demand to a rate more in harmony with what young men of similar capacity at a similar age and with similar expenditure on preparation can earn in other occupations.

The fact is that the only sound ground on which the proposed license bills can be defended is the ground that they will raise the quality of engineering work by driving out incompetent men, so that the competition of these incompetent men will be done away with, and that the public will be induced to employ engineers more because it will be assured of reliable work.

If the proposed license laws really gave any assurance of distinguishing between the competent and the incompetent, they might be defended; but the proposition to issue one broad state-wide license to a civil engineeer as competent to do any class of civil enginering work is absurd on its face to any man who knows what the term engineering today comprehends.

On one point, at least, we are in hearty agreement with the promoters of the engineers' license laws; that there is need for great improvement in the status of the profession; but the only hope that we see for such improvement is through the intelligent and organized action of the profession itself. State legislation, unless very carefully planned, will prove a curse instead of a blessing.

A Birdseye View of Conditions in the Ohio Flood Districts

(EDITORIAL CORRESPONDENCE)

Cleveland, Ohio, Apr. 8—The railroad feature of the flood situation in Ohio is more important and more serious than the outside world realizes. At this time, two weeks after the flood, the Baltimore & Ohio is not yet working its line from Cleveland to Akron or the Pennsylvania its line from Columbus to Zanesville, and so on in a large series of important lines which are still entirely out of service.

The Lake Shore maintained traffic on its main line throughout and, in fact, carried the traffic of all other roads for several days. However, its Norwalk branch was interrupted by a 40-ft. washout near Fremont on Mar. 26, which was closed on Mar. 29. It is a curious fact that some of this line's worst trouble antedated the rain storm, practically all wire communication being broken on Friday, Mar. 21, by a sleet storm.

The Big Four was hard hit. A concrete culvert at New London washed out on Mar. 25, interrupting the Cleveland-Columbus line, which was not closed till Apr. 5, but the passengers were bypassed on foot in the meantime. A three-span, high-level girder bridge on the Springfield branch of the same line crossing the Olentangy River at Delaware had its middle span shoved out by a house; no attempt has been made to close the gap. The Indiana division had washouts at Larue, Ohio, and Muncie, Ind. There was trouble at Terre Haute and Lafayette and just now much trouble at Cairo.

The Nickel Plate got through well. They were interrupted by wash of a bank at the end of a bridge near West Leipsic, Ohio, over Little Auglaize River, another west of Erie and ballast washing near Arnolds, near Fort Wayne. They have been troubled during the past week with water in Bellevue yards flooding most of the yard tracks. The Pennsylvania has been sending much traffic over this line.

The Erie reports no bridge span lost, but several pier foundations were scoured and the piers settled. Extensive trouble with ballast washing developed from near Corey to near Meadville, Penn., west of Meadville nearly to Youngstown, this side of Youngstown and also near Cleveland some banks back of bridge abutments washed out; a bridge at Old Forge west of Kent had abutment washed out and span settled; in the Akron district tracks were under water and ballast washed extensively; thence toward Mansfield at Galion, at Marion and on to Lima almost continuously. There was no trouble west of Lima. From Marion south to Dayton practically all is gone. The three worst points were Aurora, where the lake of the City Ice Delivery Co. broke and washed out the entire roadbed 300 ft., the Old Forge bridge and the Marion-Dayton section. Except for these the line was open Mar. 26, having been interrupted Monday. The Old Forge gap was closed Apr. 3 and the Aurora washout Mar. 31.

On the northern Ohio lines of the Baltimore & Ohio, water on tracks and later landslides blocked the Akron line early Monday evening, Mar. 24, and a work-train was held up just outside of Cleveland by water over the track before midnight. The Wheeling line had slight trouble Monday night by water on track, but the real interruption came on Tuesday morning, when water became too deep to run trains. Tools and men were got ready for Tuesday morning and the work-train was sent out from Lorain via South Brooklyn yard repairing line to Sterling, where water stopped progress. By work south of Sterling, the westbound track was opened to Warwick Mar. 30 and then, by using the Pennsylvania and the Cleveland, Akron & Columbus line a route was opened between Akron and Warwick. In this way the New York-Chicago line was opened Monday evening, Mar. 31. The first train through to Wheeling was on Apr. 5. Canal Dover and Beach City were bad points, as spans of 100 to 120 ft. had to be trestled because of scouring out of abutments and settling of spans, or approach washouts. On the Cleveland-Akron section, the first work-train started out on Wednesday noon, Mar. 26, and worked toward Akron, clearing slides and repairing washouts (mainly of ballast). The dynamiting of four locks of the Ohio Canal at Akron caused a large washout. The trouble on the whole section can be judged from the fact that the line is not yet open. Canton to Valley Junction was restored Mar. 3 and Canton to

Akron Apr. 6. All restoration was on virtually temporary roadbed.

It is remarkable that practically no railway culverts went out. This agrees exactly with the highway bridge reports collected by J. H. Marker's office at Columbus.

The City of Cleveland was really little affected. The high water in the Cuyahoga River, of course, reached few city interests on account of the elevation of everything above the narrow valley bottom. No sewers or other public services were affected.

As already reported in ENGINEERING NEWS, the lower West Third St. swing span was knocked off its turntable into the water by a vessel. It is now being hauled out by a derrick scow and cut up with oxyacetylene torches. The east channel is clear and the west channel will be soon.

Two city bascule bridges at Middle West Third St. and Jefferson Ave. are out of service because of wetting of the motors. These have been shipped to the factory to be baked, so that the bridges will not be working for some days longer. All other drawbridges are working and undamaged except that one of the railway lifts is reported a trifle out of line. Some old timber bulkhead was ripped out and the soil washed out behind. R. Hoffman estimates dock damage and bridge loss at less than $500,000.

The quality of the water supply is just now under public criticism and the immediate adoption of filtration is being agitated. Mayor Baker is firmly against filtration now. The matter is interesting, however, because the old æsthetic argument comes up again; that is, the question whether water is satisfactory when its bacterial count is low but its history bad. The councilmen ask how long the public is expected to be satisfied with liquid mud flavored with chlorine? The city has been working with chlorination for a year, and they increased the dosage during the flood because much sewer deposit, river sludge, etc., was washed down. The water is said to be roily still.

Columbus, Ohio, Apr. 10—In this city the Town, State, Broad and Mount St. bridges were washed out. Two of these bridges were owned by the county and two by the city. The city's bridge at Rich St., a rather old structure, just cleared the flood level and is safe. Just below is a former bridge of the Toledo & Ohio Central Ry., which is now city property, and after the flood was fitted with a 10-ft. timber deck. All communication between the city and West Side goes over these two bridges. A temporary water connection and gas connection were made over the Rich St. bridge.

Active and extensive work has been done since the flood waters subsided in restoring living conditions on the West Side. Practically nothing could be done until Thursday, Mar. 28, even in the way of rescue work, on account of the strong current, and practically nothing in the way of restoration or sanitation until Saturday. Dr. Louis Kahn took matters of sanitation in hand very energetically and the results are excellent. A volunteer force of physicians was drafted from the East Side as soon as possible and sent through the West Side for general medical service and relief. As soon as the first difficulties had been taken care of, a medical force was organized from the West Side doctors and the region divided into 18 districts, with one man in each, temporarily a medical employee of the City Health Department.

The break in the water service led to immediate notice all over the city to boil all water, which notice, as pressure was soon restored on the East Side, was then limited to the West Side. The small connection across the Rich St. bridge did not carry pressure to all parts and left the water unsafe, which it really is considered up to the present. When the 36-in. main was restored, a flushing flow through it was kept up for some time to clear the system, but of course this could not reach all parts of the system, especially in the extreme west district on high ground. Mr. Dittoe has maintained regular examination of the water, and the reports are beginning to be good; when they are quite satisfactory Dr. Kahn will at once issue general notice throughout the West Side to use only city water and that the water is safe without boiling. The situation was complicated a little by the existence of wells, especially in the few districts lacking city supply. It seems that the danger from these was avoided and the strong warning to boil water for all uses has been largely heeded.

The sewer system of the West Side was, of course, completely put out of service. There were not many cesspools or privies, but there were many non-flush outside toilets with simply a siphon bend. Immediate provision had to be made for public conveniences before any sewers could be restored and the Health Department built rough board privies all through the district in pairs, at first as nearly one every two blocks as possible and later, I think, more.

Immediate steps were taken by the City Engineer's office when the water went down for partial sewer restoration. This part of the city has a separate system. The storm sewers were left intact, only the street catch basins being filled with earth wash. The main sanitary sewer coming east from the higher district was cut into the storm sewer and service over part of the district was thus restored. The remaining sanitary sewers are being opened up through to the interceptor as rapidly as possible. The sewage-purification plant is operated only in summer, the discharge the rest of the year going direct into the river.

Of course, street cleaning has gone on steadily, there being 4 to 6 in. of mud nearly everywhere. The soldiers from the local barracks help greatly in general clearing.

There are two proposals for correcting the channel of the Scioto River to give sufficient cross-section for carrying floods. One proposal is to make an entirely new channel for the river, starting in the northern part of the city and running through the West Side close to the bluffs. The chanel would be nearly five miles. The other proposal is to straighten the present channel of the river making cutoffs at some sharp bends and widen the channel at various points.

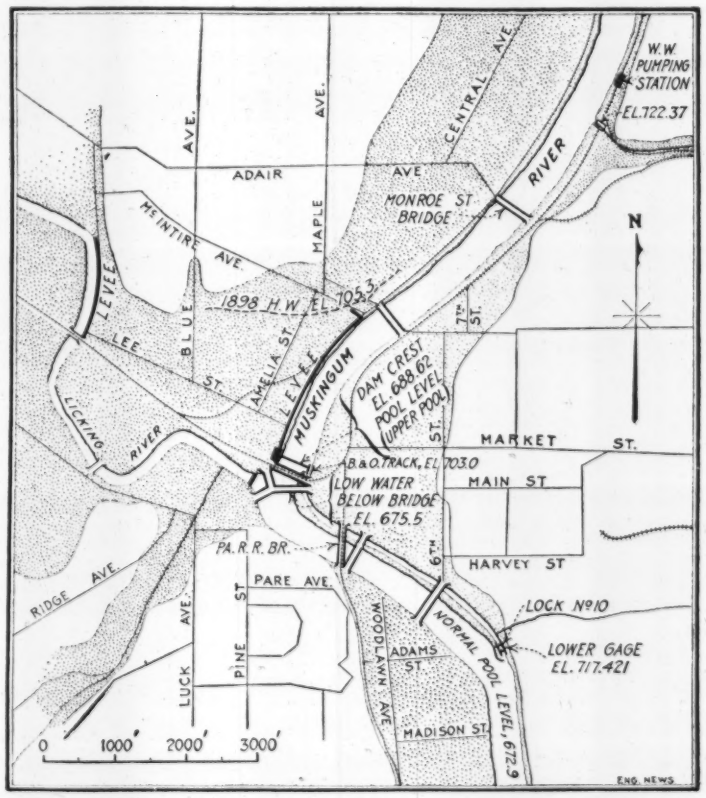
While a careful engineering investigation is really needed to determine which of these two plans would be best for the city to undertake, prompt decision is necessary, as reconstruction of the bridges which have been washed away cannot be undertaken until it is known which of the two propositions will be adopted.

Zanesville, Apr. 12—The Ohio Electric and the Baltimore & Ohio are operating to Zanesville, the latter since Apr. 2 and the former a little longer, because of having its line somewhat higher, down the Licking. The Baltimore & Ohio has splendid track to New-

ark, but thence to Zanesville most of it was overflowed, and suffered considerable wash.

I came down one tributary of the Muskingum, the Licking, and without then fully realizing it, I entered into an area of very exceptional flood phenomena. The flood here at Zanesville was radically different from the others, as may be judged from the fact that it crested here on Thursday, over two days later than the Scioto and Miami. The Licking gave evidence of enormous flow volume, as it had filled its narrow lower gorge full to the railway tracks on the hillside, and, though unobstructed by bridges, dams or encroachments, flowed along at perhaps three times normal depth and evidently with great velocity, as several hillside slides indicate.

Zanesville is a remarkable flood point. With almost no loss of life (only two or three dead), it experienced a flood of enormous volume, height, and speed of flow, which wrought vast destruction. The city's internal problems are easier and simpler than those at Columbus, but the railway isolation and the damage, present and prospective, are great. (See accompanying map.)



MAP OF ZANESVILLE, OHIO
(Showing in shaded portion the flooded district.)

The Fifth St. bridge at the north end of the city is standing. The reinforced-concrete Y-bridge in the middle of the town is intact, except for the balustrade. Two large railway and two highway bridges in the city were swept out, and below the Y-bridge clear to the Ohio at Marietta not a bridge stands. The Muskingum River at Zanesville drains an area of some 7000 sq.mi. the largest gathering-ground in Ohio, reaching up to near Akron, where the surface is 250 ft. higher than Zanesville.

The Muskingum and the Licking both have low timber dams, just above their junction, built by the Federal Government many years ago to establish slack-water navigation. These dams were no factors in the flood heights as the high water was about 29 ft. above the dam crest. Though the several bridges over the Muskingum had doubtless some effect in obstructing the flow and raising the flood level, the amount of this is hard to approximate.

The previous record flood at Zanesville occurred in 1893. At that time the depths of water on the lower gage (miter sill of Lock 10) reached 36.8 ft. In the 1913 flood the water went to 51.8 ft. on the same gage. Three-quarters of a mile above, at the Pennsylvania station, near the dam (the lock gage was here submerged) the flood of 1898 reached the floor of the main waiting room. This year it went up into the offices on the second floor, 15½ ft. higher. The slope between these two points is not yet determined, but from U. S. Engineer Office records the 1898 flood just above the dam, but northwest of the rivers went to 705.30 (sea level datum), whereas the 1913 reading on the lower gage was 717.42. The 1913 slope across the whole town is given approximately by comparing this latter figure with a level-reading said to have been obtained (by C. V. Martin) near the mouth of Mill Run, 7300 ft. above the dam, El. 722.37. This means practically 5-ft. slope in two miles.

Other elevations of interest are:
Normal upper pool, 688.62 (dam crest).
Lower pool during 1913 flood, 722.
Baltimore & Ohio track, about 703.
Low water below Y-bridge, about 675½.
Levee tops, 707.
The deck of the Y-bridge is at its summit, about 713. The flood height here was probably 719 to 721.

Several guesses at velocity of flow range from 15 to 22 mi. per hr. at maximum stage, 10 to 15 mi. per hr. during the following week. No topographical map exists, and all records of the City Engineer's office were burned last December.

The Muskingum and the Licking flow between high bluffs, except for the flat-sloping tongue of bottom land occupied by the main part of the city, a narrow strip (Putnam) along the west bank below the Licking, and portions along the Licking. Levees had been built on two short stretches, and their tops were placed 3 to 4 ft. above the 1898 flood level. The street undercrossing under the Baltimore & Ohio R.R. just west of the bridge was open for backwater, but the levees were expected to protect the northwest district from the rapid currents of the Licking.

The upper levee along the Licking was overflowed Tuesday evening, Mar. 25; water in the Muskingum was not yet high, and the lower gage showed 28 ft., or about Elev. 693.6.

Telegraphic warning was received from the Weather Bureau Tuesday morning that 5 in. of rain had fallen over the whole drainage area in the 24 hours ending Tuesday, 8 a.m., and "Look out for high water," the ordinary flood warning. No citizens believed the 1898 flood level would be passed. The Muskingum rose Wednesday morning and soon the Baltimore & Ohio bridge just below the dam was carried away (two middle spans out of four and later the east span, one still remaining). Probably the Pennsylvania bridge and the Third and Sixth St. bridges went at about the same time. The water supply failed Mar. 26, the pumping station being flooded. Rain continued and the crest of the flood was reached Thursday. On Wednesday afternoon the

water began flowing over the highest point of the Y-bridge balustrade, although on the downstream side the balustrade still showed 5 ft. above water (Tanner). At the highest stage it flowed about 18 to 24 in. over the top of the lamp-post pedestal on the upstream side (or about 5 ft. over the top of the balustrade); on the downstream side the top of the crown pedestals could just be seen.

The Y-bridge approaches being submerged after Tuesday, the city was cut into three parts without communication by person or wire. A signal service was established with large blackboards for writing messages and transits to read them. The Western Union maintained direct wire connections with New York and Pittsburgh, but took no press messages; besides, the Associated Press correspondent was marooned, which accounts for the little news that reached the outside world.

The county officials have ordered cables by express for a suspension bridge and have directed the county surveyors to prepare plans and specifications for such a bridge. Of course, the suspension bridge is to be temporary.

Main St. forms a ridge of the flat peninsula. The water flowed over it with much force, but only one serious street washout occurred, at the corner of Third St. Here a store building was wrecked; a large hole was dug by the current breaking a sewer. (Fig. 3).

The wrecking of the bridges is remarkable. Beginning at the north, the Pennsylvania bridge at Ellis, 8 mi. above Zanesville, had three deck-truss spans carried out; the west span, over the channel, was raised a few years ago and is now a through span. This west span remains, with the pier somewhat damaged. These were 133-ft. spans. There is a high earth embankment beyond both abutments; some 350 ft. at the east end and 500 ft. at the west end was washed out 40 ft. deep.

Below this is the Monroe St. county bridge. The three river spans, at high level, are standing, but of the long steel viaduct approach on the west side a 150-ft. section just back of the abutment is gone.

Fifth St. bridge, below Monroe, is still standing intact, the only one besides the Y-bridge. It has three long spans and approaches; total length about 1500 ft.

The Baltimore & Ohio bridge (entrance to Zanesville station of the Columbus-Zanesville line) consisted of four through-truss spans about 125 to 150 ft. long. That the three easterly spans were carried away is not surprising, as the track level was about 18 ft. under highest water. The westerly span stood this head, but the others went out a day before the crest stage was reached.

We are told the two middle spans gave way first. These spans now lie on their sides in the river, 50 to 100 ft. downstream. The spans appear quite square and unhurt. The east span went out after the middle two failed, and was swept under the Y-bridge, where it now lies.

The Y-bridge seems to be intact. A small washout of pavement and fill near the middle of the main crossing at the upstream side occurred, and most of the balustrade of the main crossing is gone, as is also some on the branch crossings. All of the city's traffic now goes over this bridge. The Baltimore & Ohio ends at a temporary station west of the river; the Pennsylvania terminates at Putnam station; both are reached by this bridge alone, except for an improvised ferry.

The Pennsylvania bridge just below had four 150-ft. through Pratt spans, and all four are out. The east span lies a little below the site, almost intact; the next two are under the Third St. bridge and against its piers, all wrecked; the fourth span is missing. The lower sides of the piers are torn away, back nearly to the center line at the top and running off down to the original downstream edge at the low-water line. This bridge is said to have stood the impact of houses and all kinds of floating débris until some lumber piles came along, and these, banking against the bridge and disintegrating, carried it out. The track level is practically the same as that of the Baltimore & Ohio, 703, so that the bridge was submerged more than 15 ft. over the bottom chords.

Adjoining this bridge east were a 22-ft. girder span and a 110-ft. swing span, over the canal, etc. Both were thrown off the piers. The canal furnished a short-cut for the floodwaters and they rushed down it at great velocity.

Below this were the Third St. and Sixth St. city bridges. The Sixth St. bridge has a swing span on the east end still standing, though pushed out of place; the Third St. bridge was a wooden-truss bridge of four 120-ft. spans which were destroyed. The Sixth St. bridge, of steel, comprised three main river spans, a south approach span, and a north swing span, a total length of about 600 ft. Its two easterly river spans were wrecked by a large abandoned mill striking them. The west river span went out when the Third St. bridge came against it. The approach span hung on for a time in wrecked condition, and fell down later.

All the bridges were wrecked Wednesday, which, as already said, was a day before highest stage. All of them, apparently, were wrecked by the pressure of drift accumulation or collision of large objects.

Bridge repair has hardly progressed as yet. The Baltimore & Ohio for two days has been building a trestle of framed bents, set on rock bottom, with solid blocking fitted to the broken pier tops, and will have rail connection restored to the main part of Zanesville tomorrow (Saturday, Apr. 13). The Pennsylvania has today lifted the swing span of Bridge 20 back to place and will be able to use it; the river crossing will be restored by eight 68-ft. girder spans on trestle towers, which spans happened to be available. For permanent work, both Bridge 12 and Bridge 21 will be replaced by new through-truss bridges on wholly new piers, using practically the present span-lengths.

The problems of city administration involved first, of course, relief for some 2500 persons. Absence of loss of life or serious local conditions saved much time which attention to these matters would have consumed. The condition of the public services, it soon developed, was also surprisingly good.

The water-distributing system was found practically uninjured, no mains being broken. As soon as the river dropped 2 in. below the grate-bars in the pumping station, the boiler fires were started, and the pumps began to work before they were out of the water (the pump room being a few feet lower than the boiler room). Thereafter both high-service (standpipe) and low-service (reservoir) systems were operative. This was Monday, Mar. 31, water having then been off since Mar. 26. In the interim water from springs in the higher districts was used.

Some sewers were clogged, others partly clogged, many clear. As a whole the sewer system was available as

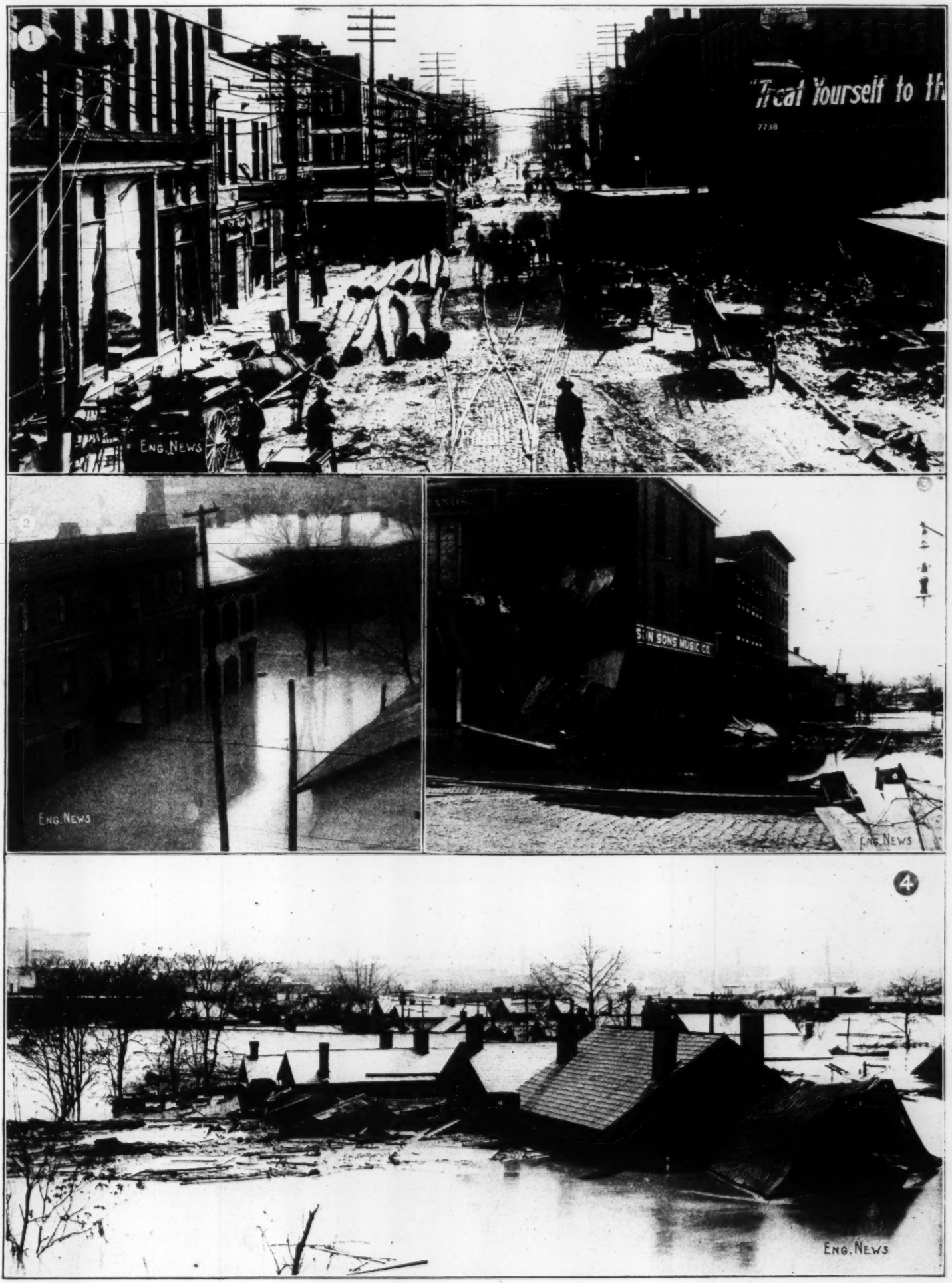


Fig. 1. Looking east on Main St. from canal lift-bridge, Mar. 30, 1913 (practically no cleaning work started).
Fig. 2. Corner South and Fourth Sts., Mar. 26 (view taken from post-office building).
Fig. 3. Street blowout from overloaded sewer (after flood went down).
Fig. 4. Looking south from Fifth St. Bridge, Mar. 28 (flood at height).

VIEWS IN ZANESVILLE DURING AND AFTER THE FLOOD

soon as the water left it. Zanesville has had many "dry-wells," closed cesspools below ground, in the gravel.

In a number of sections it was necessary to establish public privies; where possible these were built over sewer manholes. Work is proceeding in restoration of the entire sewer system.

Electric-light service is still practically non-existant, except for small private plants. Telephone service is fragmentary as yet. Street cars are operating on most of the lines.

The clearing of streets was, of course, a task taken early in hand. Mud everywhere, and débris plentiful, required to be removed. The city had and still has a large force at this work. Removal of mud and débris put on the street by householders is done by the same force.

Sanitation efforts were directed against disease: handling sick cases and watching closely for new cases. There had been some smallpox, and naturally this did not decrease. There is much chickenpox, quite a bit of measles, normal scarlet fever and diphtheria, and a considerable amount of typhoid, though the health officer, Dr. McCormick, claims it is not in excess, the normal rate being high. (Zanesville uses raw river water, has no milk inspection and no food inspection.) About Apr. 3 five cases of typhoid were reported in one day. Doubtless in part on this account the state health authorities then ordered the installation of a hypochlorite dosing plant, to supply 25 lb. hypochlorite in 10% solution per million gal. of water. This is being put in by the City Engineer, and should be operating by Apr. 12.

Zanesville is paved almost exclusively with brick. Of the 40 miles of paved streets, only about 2500 sq.yd. brick pavement was washed out or damaged.

LETTERS TO THE EDITOR

Auxiliary Flood Channels for Rivers

Sir—In reading the description of the awful havoc wrought by the recent floods in Ohio and Indiana and the various remedies proposed to prevent a recurrence of such a disaster, it struck the writer, that there has been overlooked a very effective remedy—that of constructing artificial auxiliary channels to the main river at numerous points starting near the source.

These canals could be so constructed that their bottoms at the junction with the river would be at a level a little higher than the ordinary water level in the main stream, thus they would hold water only in time of flood. The bottoms could be made so as to grade down to the river, and when the flood period is over, the water would recede and empty back into the river.

The location of these channels and their distances apart, as well as their cross-sectional area and length, would depend on their proximity to the source of the river, that they were meant to relieve.

There is no doubt, that this scheme would entail a vast expenditure of money, both for excavation of the canals and for bridges crossing them.

Nevertheless, this method of handling the flood problems appears to the writer quite practicable and worthy of further study.

H. M.

Hoboken, N. J., April 8, 1913.

[We give space to the above letter because it offers an opportunity to show by figures what such a scheme would involve.

According to the figures of Mr. Julian Griggs, the maximum flow of the Scioto River through the City of Columbus, Ohio, in the recent flood was in the neighborhood of 140,000 cu.ft. per sec. Suppose this flow is to be carried in a channel with an average depth of 15 ft. and at an average velocity of four miles an hour. Greater depth would seldom be practicable and higher velocities would cause serious erosion of the channels, banks and bottom. Computation shows that with such depth and velocity a channel would have to be nearly 2000 ft. in width to carry the flood that recently visited Columbus. If an auxiliary channel were designed to carry only a quarter of the flood it would still have to be 500 ft. in width, that is to say, *nearly double the width of the Panama Canal through Culebra Cut.*

And the Scioto River is only a single tributary of the Ohio. How big a channel would our correspondent dig to relieve the recent Ohio River flood? Where would he put his channel? It would have to follow the valley of the river for water is loth to run up hill. As the Ohio flood filled its whole valley from bluff to bluff last week, any auxiliary channel would have been submerged. —ED.]

The Status of the Engineer

Sir—A wealth of thought has been brought home to many minds since articles with the above caption have been published in ENGINEERING NEWS, but if the Editor's patience has not been exhausted, permit the writer to add a little comment to that much triangulated subject. The general reader of today finds himself beset by a variety of terms in defining what constitutes an engineer. This condition doubtless arises from the effort of modern progress to generalize, and to specify the life work for the individual without comprehending his fitness for the vocation.

The ethical side of the engineer has been pretty well written up, his scholastic requirements ditto, the pros and cons of bureaucracy dwelt upon, also the shortcomings of the politician, so there is about only one point in the discussion that has not been touched upon, viz: The commercialized side of an engineering education.

Fifty years ago an engineering education was made a specialty in a very few schools. Such education was developed, to a certain extent, by the regular college course and by the school of experience.

Today we have institutions galore all over the country, making engineers to order, graduating classes by the

hundreds, so there is a plethora in the market and disappointment for the result.

Many young men with no aptness by nature, or fitness, otherwise than is shown by a diploma, are looking for results of time spent, and money wasted. They seek legislation as an opiate for their condition, or bank on the influence of the political boss who is found in nearly every municipality, and sell their birthright like Esau of old, for a mess of pottage. Some struggle along, having some of this world's goods to fall back upon, others ally themselves with some railroad or manufacturing interest, and succeed in a measure.

Many high engineering positions in the United States are filled by able engineers from other countries, which lessens opportunities. So much for the diagnosis, now for the remedy. Stop this prevalent idea of making the human element to order in any department of life, and particularly in the engineering profession. Study fitness when choosing a vocation. An army of young men will then learn to look more carefully at the future prospects and will better understand how to win success.

AN ONLOOKER.

Burlington, Iowa, Apr. 2, 1913.

License Laws for Engineers

Sir—Several people have their little hammers out and are using the same on the proposed Engineering License Bills now pending before the different State Legislatures and against everything else which might tend to promote better conditions among those who depend on engineering work for a livelihood, be it classed as a trade or a profession.

One gentleman who signs himself N. A. Y. objects to being classed with "Veterinarians, Undertakers and Nurses." Now I think if these professions do not feel insulted over the classification, that an engineer should not object, as most of them with less training and by producing less wealth for Society are getting more compensation, both as to money and social position than at least a large part of those who class themselves as Engineers.

To believe this for one moment would be unthinkable for many Engineers; but if they will take off their colored glasses and look at things as they really are it will do them good.

The gentleman who signs N. A. Y. wrote better than he knew; for N. A. Y. is about all there is to the objections which are used against progress for Engineers along social lines.

Those who say Nay to a license law will give no common-sense reasons for their opposition; they will not attempt to substitute something else for that which they oppose; they will not try to see things from more than one viewpoint. They stand as mute rocks in the pathway of progress, content in their false pride and contempt for anything which savors of a labor union.

The Engineer will sometime recognize himself, as he really is, a hired man. Then he will be for a labor union, unless he is lifted to a higher plane by being recognized by the law of the land as a man of education with fixed standards which must be met by those who would call themselves Engineers.

Legislation will not cure all the troubles of the struggling engineering graduate. He must work out his own success, but it is a step in the right direction. Why oppose?

R. L. S.

Urbana, Ohio, Apr. 8, 1913.

The Study of Foreign Languages in Technical Schools

Sir—You have devoted much space in recent issues to the study of foreign languages in technical schools. The writer has spent some time in the study of two foreign languages and has had occasion in several instances to use his knowledge of these to good advantage, and therefore does not look upon the matter with prejudice.

In a short life of fifty to a hundred years a man cannot advance very far. If he were going to live a thousand years he could afford to equip himself with many accomplishments which under present conditions are a waste of time. Therefore in the consideration of the study of a foreign language the question should be asked, will it enable one as an engineer to know more about the principles of mechanics, mathematics, physics, geology, meteorology, astronomy, chemistry, biology, hygiene, etc., than if these subjects were studied directly with the aid of one mother tongue?

It takes much time to learn a foreign language sufficiently well to be of practical value, and the question is when thus engaged whether we are not missing something of vastly more importance. It is true some men have a fondness and aptitude for the acquirement of these languages and therefore to them it is a pleasant relaxation, which is also necessary in any educational curriculum. But there are many good engineers who may not have any more ability in the acquisition of a foreign language than in the learning of music or painting, but their material accomplishments are nevertheless of just as high character.

In the writer's judgment, the technical colleges should not require the study of foreign languages, but should afford facilities for their study to any student who considered them necessary.

The writer fully agrees with the ideas of Mr. Rudolph Hering as to the best method of studying these languages.

It would seem, too, that the time necessary to learn any foreign language could much more effectively be devoted to the mother tongue.

J. W. LEDOUX.

112 No. Broad St., Philadelphia, Apr. 7, 1913.

NOTES AND QUERIES

A few small inaccuracies are to be noted in connection with the article "Growth of a Commercial Research Laboratory," in our issue of Apr. 10. The new quarters being provided, will have twice the present floor space, which is 20,000 sq.ft. instead of the 16,000 sq.ft. noted. Compressed air is furnished (with water, illuminating gas and hydrogen) in all of the laboratory rooms instead of the few having also nitrogen, oxygen and steam and suction. Among the department adjuncts, a liquid-air plant should have been noted. The Saturday morning "colloquiums" of the staff usually consist of an informal lecture on some subject of general scientific interest, and not necessarily along the lines of work of the department. Among the important products developed was noted the magnetite-arc lamp, which a typographical error made to read "magnetic."

The Problem of Flood Control*

By Col. C. McD. Townsend†

The subject of land drainage is intimately associated with that of river improvement. A discussion of the means of preventing floods in the Mississippi Valley is therefore particularly appropriate at this meeting. In a paper read before a levee convention in Memphis last September, I briefly discussed the various means of flood control which had been suggested to the Mississippi River Commission. This afternoon I propose to confine my remarks to the three methods in which the public appears most interested, i.e., reforestation, reservoirs and levees.

Sources of Floods

As you will recall, the great Mississippi Valley is bounded on the east by the Appalachians and on the west by the Rocky Mountains. The winds blowing from an easterly direction deposit most of the moisture they absorb from the Atlantic Ocean on the eastern slope of the Alleghenies, and therefore cause little rain in the Mississippi Valley; the Rocky Mountains intercept the moisture from the Pacific Ocean. While showers occur from winds blowing over the Great Lakes, the original source of the *floods* of the Mississippi is to be sought in the Gulf of Mexico.

In all cases there is a tendency for the greatest rainfall to occur near the coast, and gradually to decrease as the wind currents travel inland. Thus the average annual rainfall at New Orleans is 60 in.; at Memphis, 52 in.; at Cincinnati, 42 in.; at Pittsburgh, 36 in.; and at St. Louis, 40 in. At the headwaters of the upper Mississippi it is but 25 in., and at the headwaters of the Missouri but 13 in.

Though floods do not arise from mean conditions but from exceptional rainfall, these figures are good indices of flood volumes. The flood discharge of the upper reaches of the Missouri is about 1 sec.-ft. per sq.mi. of drainage area; measurements at St. Paul give an extreme flood discharge for the upper Mississippi of slightly over 2 sec.-ft. per sq.mi. In the Ohio it is about 6 sec.-ft., and in the Ouachita, St. Francis and Yazoo Rivers from 8 to 10.

The maximum discharge of the upper Mississippi River is estimated at 450,000 sec.-ft.; the Missouri, 900,000; the Ohio, 1,400,000; the Arkansas, 450,000; and the Red, 220,000. There is also a large discharge from the Yazoo, St. Francis, White, Tensas and Ouachita Rivers. The maximum discharge of the Mississippi during the flood of 1912 was about 2,000,000 second-feet at Cairo, and 2,300,000 at the mouth of Red River. It overflows its natural banks when the flow exceeds 1,000,000 second-feet.

Reforestation

While the influence of forests on stream flow has received little attention in this country until recently, the scientists of Europe have discussed the subject pro and con during the past forty years. While I consider this discussion valuable, my objections to reforestation are not based solely on a scholastic argument.

It requires from twenty to fifty years to produce a good forest growth, and over a century for the leaves of that forest to decay in sufficient quantities to produce the humus which will be satisfactory as an absorbent of rainfall. We cannot afford to delay the drainage of the Mississippi Valley even to produce the forest growth, without taking into consideration the time required for the humus to form. We are more vitally interested in the height that the river will attain in the next few weeks than in what will occur in the year 2013.

It is also pertinent to this discussion to determine what would be the extent of the forest reservation, which would be required to reduce the flood heights on the Mississippi River a given amount. To solve this problem it is necessary to make certain assumptions, and for purposes of argument we will assume that reforestation would reduce the flood discharge of a stream one-half. The Mississippi flood of 1912 attained the greatest height of any then recorded, at all gage stations except at Vicksburg. That of January and February, 1913, while five feet lower at Cairo, was the next highest flood at Memphis, and for a considerable distance along the river. We will endeavor by reforestation to reduce the flood of 1912 to the heights attained in the winter of 1913. For this purpose it will be necessary to reduce the maximum discharge of the river by 500,000 sec.-ft. It will also be necessary to distribute this reduction among the tributaries, reducing the maximum discharge of the Missouri River from 900,000 to 700,000 sec-ft., that of the upper Mississippi from 450,000 to 350,000, and that of the Ohio River from 1,400,000 to 1,2000,000.

As stated above, the flood discharge of the Missouri River at its headwaters is about 1 sec-ft. per sq.mi. of drainage area, and if the reduction in discharge of one-half is to be secured by reforestation, two square miles of forests would be necessary for every second-foot of reduction of flood discharge, or 400,000 square miles of forests to reduce the discharge of the Missouri River 200,000 sec.-ft.

At the headwaters of the upper Mississippi, the ratio of flood discharge to drainage area is about 2 sec.-ft. per sq.mi. A reduction of this discharge by one-half would require a forest reservation of 100,000 square miles to reduce the floods of the upper Mississippi 100,000 sec.-ft. On the Ohio River the ratio is 6 to 1, and it would therefore require forests at the headwaters of the Ohio having an area of 66,000 square miles to reduce its flow 200,000 sec.-ft.

In other words in order by reforestation at the headwaters to reduce the height of a flood at Memphis from that of 1912 to the next highest on record, it would require a forest reservation of about 566,000 square miles, an area exceeding that of the portions of Montana and Wyoming drained by the Missouri River and the entire states of North and South Dakota, the portion of Minnesota drained by the upper Mississippi River, and the states of Iowa, Wisconsin, Illinois and Indiana.

But even such a forest reservation would afford only partial protection against floods and large expenditures for levees would still be required. Under even the above extreme assumptions, to prevent any overflow of the rivers by reforestation would necessitate a practical abandonment of the Mississippi Valley for agricultural purposes, and the development of an extensive irrigation system to produce tree growth in the arid region of the West.

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*Condensed from an address before the National Drainage Congress, St. Louis, Apr. 10.

†Corps of Engineers, U. S. A., President of the Mississippi River Commission.

It is therefore apparent that even under the most extravagant claims of forestry advocates, reforestation as a means of reducing flood heights on the Mississippi River requires the conversion of too much farming land into a wilderness to be practicable.

Reservoirs

To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Illinois, having an area of 7000 square miles, slightly less than that of the state of New Jersey, and a depth of about 15 ft., assuming that it would be empty when the river attained a bank-full stage. If the site of such a reservoir was a plane surface, the quantity of material to be excavated in its construction would be over 100,000,000,000 cubic yards; and its estimated cost from fifty to one hundred thousand million dollars. Such a volume of earth would build a levee line 7000 miles long and over 150 feet high.

Cairo is the logical location for a reservoir to regulate the discharge of the lower Mississippi. It would not only control the floods from the Ohio but also the discharge from the Missouri and upper Mississippi. But if the reservoirs be transferred from the mouths of the tributaries to the headwaters, their capacity must be largely increased. No two Mississippi floods have the same origin. If the prevailing winds in the early spring are from the southwest, the southern tributaries of the Ohio furnish the crest of the year's flood; if more nearly from the south, reservoirs will be required on the streams of Ohio, Indiana and Illinois; a slight varying of the wind will produce a flood in the upper Mississippi, while if it blows from the southeast the principal sources of trouble will be the Red, Arkansas and Missouri Rivers.

To control the flow of every stream in the Mississippi Valley by reservoirs is a pretty large job, even for the United States Government; but that is what the control of the Mississippi during floods by reservoirs signifies.

The advocates of the control of the floods of the Mississippi by reservoirs do not, however, have in mind any such radical control as is above indicated. They limit the control to the headwaters of the various tributaries, and while every stream that flows in the valley may be considered a headwater of some tributary, I judge from the discussions of the reservoirs and their proposed employment for power purposes, which requires a considerable height of dam, that by headwaters is meant the sources of the rivers in mountainous countries as distinguished from the more level plains, and more specifically the sources of the Missouri above the mouth of the Yellowstone, those of the upper Mississippi in the state of Minnesota, and those of the Ohio in the Appalachian Range.

The flood which is now devastating the country affords data for determining the effect of such a system of reservoirs; and its lessons are the more valuable because no effort is necessary to refreshen the memory. When on Apr. 2 the gage at Cairo attained a height of 54 ft. there was flowing by it down the Mississippi River at least 2,000,000 cu. ft. of water per second.

It requires about eleven days for a flood wave to travel the 966 miles between Pittsburgh, Penn., and Cairo; on Mar. 22 the Pittsburgh gage read 5.3 ft., which is produced by a flow in the Ohio River at that locality of about 15,000 sec.-ft. In ten days a flood travels the 858 miles between St. Paul, Minn., and Cairo; on Mar. 23 the reading of the St. Paul gage was 0.5 ft. corresponding to a discharge of the Mississippi of about 2500 sec.-ft. In eight days the effect of a flood at St. Joseph, Mo., is felt at Cairo; on Mar. 25 the gage at St. Joseph read — 0.1 foot, representing a discharge of the Missouri River of about 17,000 sec.-ft.

If a system of reservoirs had been constructed which would have prevented all flow from the Allegheny, the Monongahela, the Mississsippi above St. Paul, and the Missouri above St. Joseph, it would have reduced the 2,000,000 sec.-ft. discharged by the Mississippi River at Cairo on April 2 less than 35,000 sec.-ft.

The water which passed Cairo on the 2d of April came principally from the White and Wabash and the lower tributaries of the Ohio, and after the water of these rivers started to subside, the flood from Cincinnati, though increasing from 57 ft. to 69 ft. on the gage at that place, could increase flood heights at Cairo less than one foot. The flood of 30 ft. at Pittsburgh on Mar. 28 produced its effect on the Cairo gage day before yesterday (Apr. 8). It has prolonged the flood without increasing its height.

Such a proposed system of reservoirs would have cost hundreds of millions of dollars and its effect on this year's flood height of the lower Mississippi could not possibly have exceeded six inches.

Neither the rain nor snow which falls upon the mountainous portions of the Mississippi watershed has much effect upon the floods of the lower river. The principal source of the floods is the great alluvial plain between the mountains. As I have pointed out, excepting the southern tributaries of the Ohio, the rainfall is relatively slight at the upper sources of the tributaries and their maximum flood discharge does not usually coincide with that of the mid-valley.

Great floods do not arise from average conditions, but from exceptional variations such as are caused by a series of heavy rains rapidly succeeding one another. Each rainstorm starts down a stream a flood the volume of which can be absorbed by a reservoir with comparatively little trouble, but if a second storm sweeps over the valley, the reservoir to be effective must be emptied or its capacity doubled. To hold all the excess rainfall till low water, would require reservoirs of enormous capacity. Economic considerations usually require that the reservoirs should be emptied as soon as the crest passes, in order to utilize the same space for a second rainfall; so that while reducing the crest of a flood at a given locality, they necessarily prolong the period during which the river remains at a high stage.

The water which is abstracted from the Gulf of Mexico is usually precipitated in the Mississippi Valley within a period of two days. The return flow extends over a period of two or three months. The sum of the maximum discharges of the various tributaries of the Mississippi River is nearly 4,000,000 sec.-ft., while the greatest measured discharge of the river itself is about 2,300,000. This apparent discrepancy arises from the fact that the floods of the tributaries do not reach the Gulf at the same time. The crest of the Ohio River flood usually passes down the river in March or April, that of the Missouri in May or June. Moreover, the same law applies to the tributaries of a tributary. The waters of the southern branches of the Ohio tend to discharge

into that river before those in Ohio, Indiana and Illinois.

By the construction of reservoirs this beneficent law of nature is deranged. Instead of the crest of the flood of one stream passing down the river before that of another reaches it, two prolonged high stages will obtain, which will tend to synchronize, and the resultant combination may be higher than either flood would have been by itself.

A system of flood control designed to be satisfactory for one city may be most disastrous to another locality further downstream. If a system of reservoirs had been in operation in the Allegheny and Monongahela Rivers during last January, it would have protected Pittsburgh from overflow and diminished the flood at Cincinnati when it was 50 ft. on the gage, but only to increase it when it attained a height of 60 ft. And this effect would have been propagated to the Gulf.

Pittsburgh, moreover, would never consent to such a manipulation of reservoirs on the upper tributaries of the Ohio as would insure the reduction of floods at Cincinnati or on the lower Mississippi. Source stream control on the Mississippi River and its tributaries would, therefore, soon reduce itself to the question whose ox is to be gored.

Levees

While the use of forests or reservoirs as a means of flood control is still in an experimental stage all over the world, the employment of levees for this purpose has been tested for centuries. The Po, the Rhine, the Danube, the Rhone and other rivers of Europe have been successfully leveed. The laws governing the flow of water in a confined stream have been carefully studied and the construction of levees is just as susceptible of mathematical analysis as other engineering problems.

There is an element of uncertainty in all the forces of nature. No one can say positively, for instance, that St. Louis may not at some future time experience an earthquake, or a tornado of greater intensity than that which swept over the city in 1896. There is also a possibility that there will be some combination of meteorological conditions which will create a flood of greater volume than has heretofore occurred in any drainage area. But the height to which levees should be constructed is as susceptible of determination as the strains to be permitted in an office building due to wind presure, or the moving load allowable on a bridge. The city engineer solves a similar problem whenever he constructs a sewer to carry off the storm water from the city streets.

Nor is there any evidence either that floods have been increasing in recent years due to the cutting off of forests or that the beds of our main rivers are rising as they are lowered. The records at London, Paris, St. Petersburg and other localities where the rain has been recorded for long periods fail to show any tendency to an increased fall in recent years.

The meteorological records of the United States have not been maintained a sufficient length of time to be of much value in solving the problem but such data as we possess indicate that the flood discharge has not increased in recent years. The greatest flood of the Mississippi at St. Louis occurred in 1844, the next largest in 1785. On the Great Lakes the high water of 1838 is the greatest on record. In the Ohio, the flood of 1884 exceeded that of 1913 at Cincinnati, and that of 1832 while five feet lower at Cincinnati was five feet higher at Pittsburg than this year's flood. The gage records at the bridges over the upper Mississippi which cover a period of thirty years would indicate that the flow from Minnesota and Wisconsin where the forests have been most extensively destroyed during the period, has been slightly improved, though the river shows signs of deterioration where it receives the flow from the prairie lands of Iowa and Illinois. They appear to confirm the conclusions of the German Forestry authorities that the influence of forests on drainage is concealed by other causes more powerful in their effects.

There is not the remotest connection between deforestation and the disasters which have just occurred at numerous cities in Ohio and Indiana. The flood of 1832 was similar to that of 1913 but it was discharged by streams of the dimensions the Creator intended they should have. Since then cities have sprung up and land has become so valuable that riparian owners have encroached upon the waterways. Where the floods formerly flowed untrammeled, factories and dwellings have been constructed, and numerous bridges have further restrained the stream's discharge. When His laws are violated, though slow to anger, the Creator occasionally asserts His might and the works of man crumble before Him. If it would accomplish any useful purpose, I could name other cities where conditions are as dangerous as at Dayton or Columbus, but the lessons of the flood will be forgotten with the burial of its dead.

The question of the rise of the river bed by levee construction has been exhaustively investigated. On the Rhine the maximum effects were observed at Düsseldorf where the same discharge at low water appears to attain a height 8 in. greater today than it did 100 years ago, while the same discharge at high water has lowered about one foot in a century. On the Po, the maximum observed change in low-water conditions was 0.02 of a foot per year, but it is by no means proved that even these small changes have resulted from levee construction. They may have arisen from the improvements in the river bed which were made simultaneously with levee construction. The observations of the Mississippi River Commission agree with the Düsseldorf observations in that the Mississippi River appears to be slightly enlarging its section, at least at mid-stages.

The present contents of the adopted levee line of the Mississippi River is about 243,000,000 cu.yd. It has been computed that with an addition of 200,000,000 cu. yd. at an estimated cost of $57,000,000 this line would be safe against any flood which has occurred in the Mississippi River. This sum, though large, is less than $4 per acre of land protected from overflow, and appears insignificant when compared with the amounts which are being expended per acre for irrigation purposes in the arid west. The increase in the value of land or the damage caused by one overflow like that of 1912 would pay for the completion of the levee system.

When a levee line contains but one-half the material that safety requires, crevasses afford no argument against levee construction. During the flood of 1912 hundreds of miles of levees were topped with earth in sacks to a height of from two to four ft., to prevent the water flowing over them, and water was seeping through their narrow bases in copious streams which was unheeded until

mud began to flow. The levee which failed at Beulah, Miss., this winter was held till the pile of sacks exceeded 20 ft. in height.

The holding of 1525 miles of such levees through the flood of 1912, even though 13 miles failed, is a powerful argument in favor of a properly constructed levee line. There was no failure where levees were built to a suitable grade and adequate dimensions as in the upper Yazoo District.

Conclusion

While I am of the opinion that levees afford the only practicable method of controlling the floods of the Mississippi River, I desire to state that I am strongly in favor of both reforestation and reservoir construction, but limited to the purposes for which they are adopted, just as I am in favor of reinforced concrete for small bridges though not considering it applicable to one spanning the lower Mississippi River.

The price of lumber today is a sufficient argument for planting trees, without attempting to associate forestry with the climate or with the flood conditions on our rivers. If the Federal government or the states do not conserve the forests, the time will soon come when the farmer will raise his crop of timber just as now he plants a field of wheat, and for the same reason, because it will pay him to use his waste land for the purpose.

Reservoirs are necessary for municipal water supplies, for purposes of irrigation, for the development of power, and for feeeders to canals. They can be successfully employed on small streams to diminish floods or increase the low-water flow. The trouble arises when an attempt is made to utilize them for too many purposes at the same time. There must be a paramount issue to which the others will be subsidiary.

If the main purpose is to supply a city with water, only the excess can be used for power development. If the dams are constructed to produce power, the reduction of floods and the improvement of river navigation must be subordinate thereto. Water required for irrigation can only be used to develop power when the dam of the storage reservoir is given a greater height than is necessary for its flow over the land to be reclaimed.

During the next decade there will be an enormous development of reservoirs both for irrigation and for power purposes, which I hope will be utilized to correct man's folly and prevent many disasters similar to those which have recently occurred in Indiana and Ohio. While the control of the lower Mississippi by reservoirs is impracticable, there are numerous smaller streams where they can be used with excellent results.

It is questionable, however, whether such reservoirs should be built with the control of our rivers the first object of consideration. It will, to be sure, saddle the cost on the United States Treasury, but to close down a power plant and stop the growth of crops every time that the navigation of a minor stream is interfered with, I do not consider would be a wise proceeding.

I am also sceptical of government ownership. It may have worked satisfactorily in irrigation projects, but my experience with government ownership of water-power makes me suspicious. I have found that when the government buys water-power, the power companies consider it worth $25 per horsepower per year, but when conditions are reversed and an attempt is made to lease it, the price drops to ten cents.

The systematic conservation and regulation by the Government of a river from its source to its mouth sounds most attractive, suggesting a scientific solution of every problem of river hydraulics, but instead I greatly fear that it is the voice of a siren luring the people to an open pork barrel for every stream in the United States.

The Flood at Indianapolis

By Dewitt V. Moore*

During the week beginning Sunday, Mar. 23, 1913, Indianapolis suffered the most disastrous flood in the history of the city.

Following the first destructive wind storm of the previous Friday night, rain began to fall Sunday morning at 6:10. The rainfall at Indianapolis as shown by the reports of the weather bureau from 6.10 a.m., Mar. 23, to and including Mar. 25, amounted to 5.59 in. The detailed report for the entire week is as follows:

	In.
Mar. 23	1.27
Mar. 24	2.76
Mar. 25	1.56
Mar. 26, snow, rain and sleet	0.34
Mar. 27, snow	0.08
Total	6.01

This rainfall was general as is evidenced by the floods at other points.

On Monday it was evident that Indianapolis could expect a disastrous flood and by early Tuesday morning it was certain that the water would surpass any before experienced.

After eight or nine o'clock Tuesday morning events happened so fast that it was impossible to keep in touch with conditions. The first to suffer were the lowlands along the river insufficiently protected by levees. About nine o'clock on Tuesday morning traffic was suspended on several of the bridges across the river and every effort was being made to protect property and lives against the overtopping of the levees.

The accompanying map of the city, prepared from one furnished by the courtesy of the Indianapolis Traction and Terminal Co., shows the principal structures affected by the flood and the extent of the high water. The various bridges and localities referred to below are noted on the map by numbers in parentheses.

At 11:20 a.m., Tuesday, the Power House of the Indianapolis Traction & Terminal Co. was under water and the traffic on all city car lines was suspended. This shutting down of power of the local Traction Co., applied not only to the new plant at West 10th St. (13) and the river, but also to the old plant on West Washington St. (20). The two plants being put out of service at practically the same time.

The Indianapolis Water Co. was compelled to shut off all water supply at 10:30 p.m., Tuesday, and the city was without fire protection until 7 a.m., Friday, Mar. 28.

Tuesday afternoon the water from Fall Creek overtopped the west bank and entered upon the lowlands west and north of 30th St. bridge (14), the main flow being across 28th, 27th and 26th Sts., reëntering the creek at Pennsylvania St. just east of Meridian St., as noted on the map. The flood water swept over the bottom lands adjacent to Fall Creek west of Capitol Ave., and on down

*Consulting Engineer, Merchants' Bank Bldg., Indianapolis, Ind.

to Northwestern Ave. bridge (8) and again widened out below until the creek joined the river at West 10th St., opposite the Traction Terminal Co., new power plant. The Indianapolis Gas Co., on the south bank just west of Northwestern Ave., was one of the public utilities first to suffer.

The excessive flow of Fall Creek in connection with the breaking of the levee on the south bank of White River west of the Belt R.R. bridge (17), resulted in the backing up of flood water at the Traction Terminal Co.'s plant at 10th St. and the washing out of the Belt. R.R. from 10th St. to the bridge.

As a matter of fact, illustrating the railroad situation, the Belt R.R. suffered washouts from the crossing of White River mentioned above, northwest of the

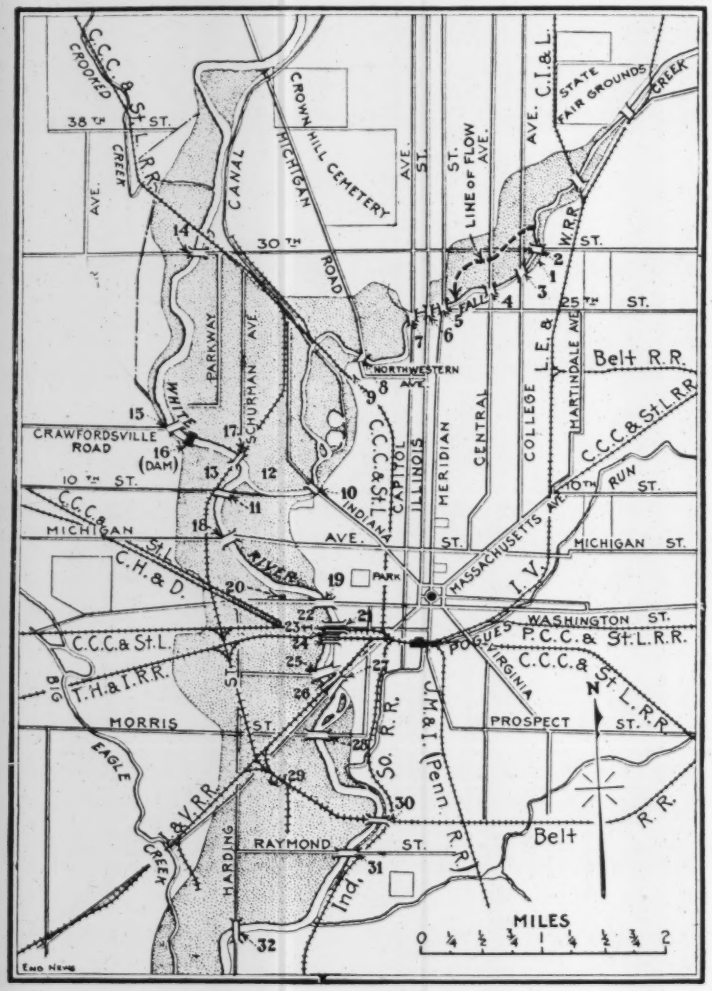

FIG. 1. MAP OF INDIANAPOLIS, SHOWING FLOODED DISTRICT SHADED

city, to the second crossing of White River almost directly south.

The advance of the flood was so rapid and the breaks in the levees so numerous that it is not worth while to express an opinion as to where the first break occurred, but it is sufficient to say that almost the entire west and southwest portion of the city was one seething, rushing flow of water without any opportunity being offered to the main portion of the city on the east and north, to assist the sufferers or gain an adequate idea of the damage.

One man standing on the top of a box car on the Big Four overhead crossing of West Washington St. (19), just beyond the Power Station of the Traction Co., stated that as far as he could see to the south and southwest it was nothing but water submerging practically all the territory, houses in some cases being entirely submerged, and the only visible land being the embankments for the railroads and levees. It is hard to estimate the depth of water in this submerged territory, but it is probably safe to say that it was on an average of 10 to 12 ft. with a maximum depth much greater.

At a point just north of College Ave., on the south bank of Fall Creek, the rush of water undermined Sutherland Ave. and the tracks of the Union Traction Co. The bank beneath the track was completely washed away and the tracks dropped into the creek. Above this point and on the west side the water gained entrance to the lowlands west and north as previously mentioned. The 30th St. bridge (2), a reinforced-concrete structure, withstood the flood as also did College Ave. bridge (3), and the Central Ave. bridge (4). Between Central Ave. and Capitol Ave. (7), the south bank of the creek is protected by a boulevard with a permanent roadway which was laid out on a sinous line with a very decided curve approaching the south abutment of the Meridian St. bridge (5). This curve projected out into the stream and to a large extent obstructed the flow through the south span. At this point we also have the bypass current, entering above 30th St., reëntering the creek opposite this curve in the boulevard.

Congestion of water and the complex currents resulted in the undermining of the upstream end of foundations of this bridge, causing the failure shown in Fig. 2. It will be noted that this is a collapse of the upstream one-half of the bridge on a longitudinal line.

The appearance is almost as clean cut as a sectional drawing. The west half of the bridge appears to have suffered no harm but the current swinging again to the north caused a large slide in the gravel fill of the boulevard improvement on the north bank west of the bridge.*

Next below the Meridian St. bridge is the Illinois St. bridge (6). (The Meridian St. and Illinois St. bridges were built the same year from the same plans.) This bridge withstood the flood although on account of the anxiety of the moment the bridge was closed to traffic. Both the Illinois St. and Meridian St. bridges just referred to were of Melan construction using I-beams for reinforcement. In the photograph of the Meridian St. bridge (Fig. 2), several of the ribs may be seen in their present fallen condition, no doubt caused by the lack transverse reinforcement. These two bridges were constructed about 1900 and were the first of the better class of bridges crossing Fall Creek and White River. Neither bridge was on piles and the foundations were no doubt affected by the large amount of dredging during the last five years by gravel companies and contractors in the construction of the boulevards on each side of the stream.

The Capitol Ave. bridge constructed in 1912 of reinforced-concrete design and one of the finest bridges in the city passed through the flood in perfect condition, although the waterway of this bridge was insufficient. This bridge was for a long time the main means of communication between the north and south sides of the creek.

The Northwestern Ave. bridge (8) withstood the flood. Just west of this bridge on the south side (9) is the

*The Meridian St. and Illinois St. Bridges were described in "Engineering News," Apr. 11, 1901, p. 258.

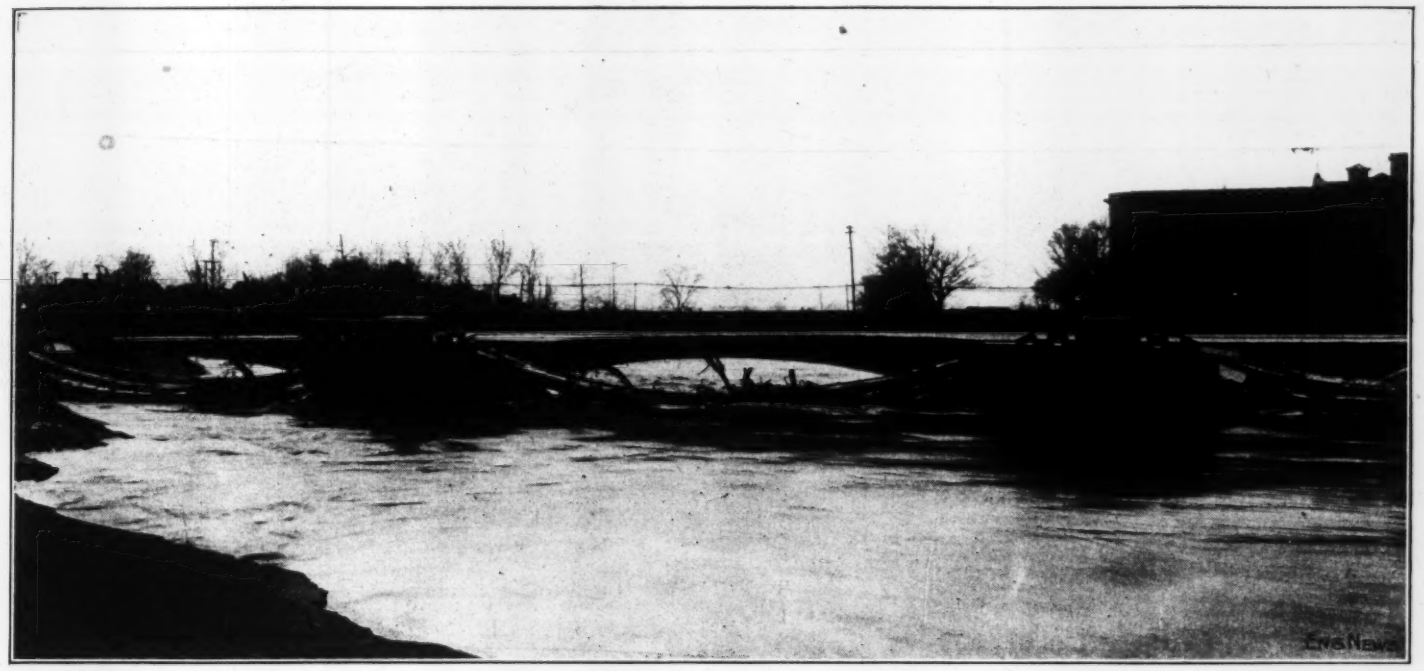

FIG. 2. PARTIAL FAILURE OF MERIDIAN ST. BRIDGE

plant of the Indianapolis Gas Co., which was flooded early in the day. The Indiana Ave. bridge (10) suffered to some extent but a complete report cannot be made at this time.

There was considerable damage done between this point and the West 10th St. bridge (11), the roadway and the bottomland being entirely submerged, flooding the pumping station of the Indianapolis Water Co. (12), and contributing to the damage at the West 10th St. station of the Traction Terminal Co. (13). The water is reported as having been two feet over the 10th St. bridge (11), a steel truss with wood floor. It was reported that this bridge had failed but notwithstanding the extreme conditions the bridge is apparently in good condition outside of washouts of approaches. The West 30th St. bridge over White River (14), the Emmerichville bridge (15) both of which were elaborate reinforced-concrete designs of considerable cost seem to have withstood the flood with little damage notwithstanding some reports to the contrary.

Next below the 10th St. bridge is the W. Michigan St. bridge (18), across which travel was suspended about 9:00 a.m. Tuesday. This bridge, however, passed through the flood without damage. The suspension of traffic was due to the low ground on the east approach, this ground being entirely submerged. At this point numerous houses were removed from their foundations and the current across these bottoms is described as being tremendous.

The next crossing at W. Washington St. (19) was a deck plate-girder bridge with a concrete floor. This

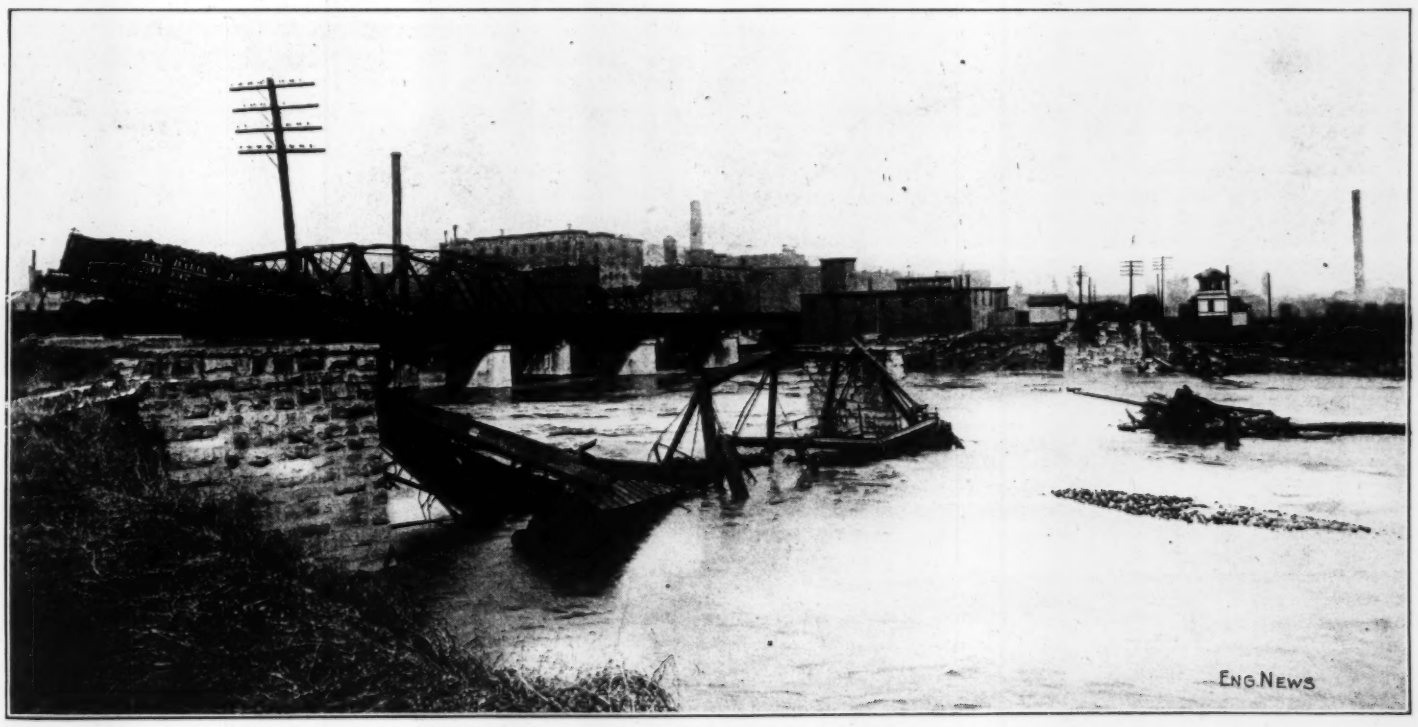

FIG. 3. WRECK OF VANDALIA R.R. BRIDGE

bridge began to fail Tuesday evening and by Wednesday was a complete failure. At 10 o'clock Tuesday the east bank was rapidly crumbling and at this time the water had already flooded Washington St. west of the power house of the traction company (20).

The next bridge, the property of Kingan & Co. (21), was wrecked.

Immediately adjacent is the new Vandalia R.R. bridge (23), which was apparently not damaged. Next is the old Vandalia R.R. bridge (24), which is a complete wreck (see Fig. 3).

The Oliver Ave. bridge (25), a through-girder construction with concrete pavement and stone railing, passed through the flood successfully although the waterway was entirely closed. The old I. & V. R.R. bridge (26) is almost a complete wreck.

Next is the Kentucky Ave. bridge (27), a bow-string steel truss of two spans which was seriously affected by the undermining of the foundations. From the Washington St. bridge down to the Kentucky Ave. bridge and beyond, the west side of the river is protected by a levee which was soon overtopped, resulting in the inundation of West Indianapolis and this flow was supplemented by the water bypassing across West Washington St. west of the Traction Co. power house. Below the Kentucky Ave. bridge the Morris St. bridge (28), a reinforced-concrete bridge, withstood the flood. The water spread out in the bottom below Morris St. and supplemented by the flow through West Indianapolis attacked the Belt R.R. fill between this point (29) Stock yards and the Belt R.R. bridge (30), causing an almost complete washout of this part of the Belt R.R. embankment.

Below the Belt R.R. the Raymond St. bridge (31) was partially destroyed and the Harding St. bridge (32) was damaged.

The nearest approach to this flood was in 1904 when the gage read 21.3 ft. The gage was destroyed by the recent flood, but the height has been determined by the Weather Bureau as 25.7, an increase of 4.4 ft. The unexpected happened and the restricted channels of Fall Creek and White River were not capable of such a tremendous flow, neither were the levees of sufficient strength or height.

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A Railway Accident in Congo, Africa, is reported to have caused the deaths of 23 persons on Apr. 5. According to press dispatches an entire train fell from a bridge into the Congo River, near Bonea, Belgian Congo.

A Butting Collision between an express passenger train and a freight train is reported to have caused the deaths of 33 passengers and several railway employees, on the Austrian State Rys., near Karlstadt on Apr. 6.

The Derailment of a Passenger Train on the Mexican Central R.R., near Tula, Hidalgo, Mex., is reported to have resulted in the deaths of 20 passengers on Apr. 10. According to newspaper reports the engine-driver was speeding to escape a band of rebels.

A Report on the Ohio Valley Floods is to be made by a Board of Engineer Officers appointed by Secretary of War Garrison. It's members are as follows: Lieut.-Col. Francis R. Shunk, Pittsburgh; Lieut.-Col. Henry Jervey, Cincinnati; Maj. Charles S. Bromwell, Cleveland; Maj. John C. Oakes, Louisville; Maj. Frederick W. Alstaetter, Wheeling; Maj. Louis H. Rand, Cincinnati.

The Capsizing of a Stranded Ship on the beach of Nehalem Bay on the coast of Oregon caused the drowning of 18 men on Apr. 6. The wrecked ship was the German bark "Mimi," which went ashore on Feb. 13. The ship had not been seriously injured and the underwriters had made arrangements with the Fisher Engineering Corporation, of Portland, Ore., to float the vessel. Mr. Fisher and eight of his employees, a representative of the underwriters, the captain of the "Mimi" and 11 of the crew were on board the vessel Apr. 6, when a storm came up and made it impossible to take them off. Later Mr. Fisher, the captain and two sailors were rescued, but the remaining 18 men were drowned.

Plans for the Infirmary Group of Buildings for the Chicago Municipal Tuberculosis Sanitarium have been completed and with specifications will be ready for bidders about Apr. 21, 1913. The buildings, which are estimated to cost about $600,000, will include an administration building 98 ft. long, and two wings each 430 ft. long, the whole H-shaped in plan and two stories high. The exterior and interior walls will be of brick, minor partitions of tile, floors and roofs mainly of reinforced concrete, with floors surfaced largely with tile. Heating, refrigerating and compressed air (for future vacuum cleaning system) plants will be provided. The infirmary will provide for 250 patients in single and double rooms and in six-patient wards. Frank E. Wing, Fort Dearborn Building, Chicago, is general superintendent of the sanitarium.

A Freight Subway on the west side of Manhattan Island, New York City, will be built for the readjustment of the freight tracks of the New York Central & Hudson River R.R. and their removal from the streets of the city, according to a proposition now before the Board of Estimate and Apportionment (devised by a committee of that board and reported accepted by the mayor and the railroad company).

The older proposal for an elevated freight terminal railway to be owned by the city and available for all railways, as advanced by the then Commissioner of Docks, Calvin Tompkins (see Engineering News, Apr. 13, 1911), would be superseded by this plan which requires no cash from the city (so long as the service is wholly for the New York Central). The plan involves an expenditure of some $50,000,000 by the railroad and city, of which the city contributes $7,322,413 in the form of real estate and easements. The city is to receive from the railroad $163,888 for various parcels of land in the northern part of the island.

The plan includes all the west-side tracks from the city line, on the north, to Cortlandt St., on the south, these being in a tunnel or subway, and on elevated structures, variously alternating with certain open stretches and river side freight yards. A two-track subway would be built by the railroad from its enlarged 30th St. yards down Tenth Ave., Washington, Canal and Varick Sts., to its St. John Place yards.

The railway company asks an option to substitute for the Canal St. subway a continuation of the Washington St line as far as Barclay St. As this line would be exclusively for the New York Central, the committee has secured an option for the purchase of the railroad's rights and the construction of these facilities below 30th St., making them open to all railroads on equal terms and giving a chance for a joint terminal railroad.

The Architectural Design for a County Court House in New York City, submitted by Guy Lowell, has been selected in the competition which recently closed. In all, 22 sets of plans were submitted to the board of judges by eminent architects of the United States, 10 by invitation and 12 after a preliminary competition. The building is notable on account of its great size and cost, and Mr. Lowell's design is novel in that it shows a circular plan and has a faint resemblance to the Roman Coliseum. There will be a central lobby with passageways to portals on the north, east, south and west. Mr. Lowell is reported as stating that the circular plan was developed, not on account of the appearance of any Roman prototypes, but because of the necessity of economical construction and of securing the maximum amount of light and air, together with the elimination of long corridors. On the ground floor, adjoining the entrances will be the non-litigation offices which are most used, so that it will not be necessary to crowd the elevators with people bent on the more easily dispatched business. Above, there will be one complete floor for the city-court rooms and four floors for the various supreme-court session chambers. Above these still, will be the library and dining rooms for the justices and over this the justices' chambers, making eight stories in all. Separate elevator service is proposed for the public and the justices, juries, etc. The building will cover about 120,000 sq.ft. and will cost approximately $10,000,000, of which sum the architect will receive a fee of 6%. The north-south axis of the building will coincide with the line of the present Center St. bridge-loop subway; it is expected that novel foundation problems will have to be solved on account of the subway and because of this location on the site of the old Collect Pond.

PERSONALS

Mr. T. R. Atkinson, M. Am. Soc. C. E., State Engineer of North Dakota, has resigned to engage in private practice.

Prof. Edward L. Nichols, M. Am. Inst. E. E., has been made Dean of the College of Arts and Science, Cornell University. Prof. Nichols is now Professor of Physics.

Mr. Alfred E. Kornfeld, Assoc. Am. Soc. C. E., late Business Manager of "Engineering News," has been elected Vice-President of Bischoff's Bank, New York City.

Mr. Frederick Palmer, M. Inst. C. E., has resigned as Chief Engineer to the Port of London Authority to become a Consulting Engineer and partner of Sir Alexander Rendel, M. Inst. C. E.

Mr. C. R. S. Kirkpatrick, M. Inst. C. E., has been appointed Chief Engineer to the Port of London Authority, succeeding Mr. Frederick Palmer, M. Inst., C. E., resigned, as noted elsewhere.

Mr. H. C Donecker, Secretary of the American Electric Railway Association, has resigned, effective July 1, to accept the position of Assistant General Manager of the Public Service Ry., Newark, N. J.

Mr. George H. Aykroyd, for the past 10 years Chief Draftsman of the roll department of the Lackawanna Steel Co., has been appointed Superintendent of the roll department of the Pittsburgh Crucible Steel Co., Midland, Penn.

Mr. G. M. Rice, Assistant Engineer of the Chicago, Milwaukee & St. Paul Ry., has been promoted to be Division Engineer at Spokane, Wash., succeeding Mr. A. G. Holt, M. Am. Soc. C. E., promoted to be Assistant Chief Engineer, as noted in our issue of Feb. 13.

Mr. W. D. Jenkins, former Secretary to the Vice-President and General Manager of the Denver & Rio Grande R.R., at Denver, Colo., has been appointed Inspector of Transportation of the International & Great Northern and the Texas & Pacific Rys., at Houston, Tex.

Mr. Nicholas F. Brady, Assoc. Am. Inst. E. E., Vice-President of the New York Edison Co., has been elected President, succeeding his father, Mr. Anthony N. Brady, who becomes Chairman of the Board of Directors. Mr. Brady is 34 years old and a graduate of Yale University, class of 1905.

Mr. Charles Whiting Baker, M. Am. Soc. M. E., Editor-in-Chief of "Engineering News," has been appointed by Governor Fielder, of New Jersey, and Governor Sulzer, of New York, a member of the Palisades Interstate Park Commission, which has control of the Palisades along the western bank of the Hudson and of the large tract of land given by Mrs. Harriman.

Mr. B. S. Josselyn has resigned as President of the Portland (Ore.) Railway, Light & Power Co., which position he has filled for the past six years. During Mr. Josselyn's term of office several large hydro-electric power plants have been constructed and many miles of electric railway have been added to the company's system—involving a total expenditure of $24,000,000.

Mr. J. W. Small, formerly Superintendent of Motive Power of Morgan's Louisiana & Texas R.R. and Steamship Co., Assistant General Manager, mechanical department of the Galveston, Harrisburg & San Antonio Ry., Houston, Tex., has been appointed Superintendent of Motive Power of the Seaboard Air Line Ry., with headquarters at Portsmouth, Va., succeeding Mr. A. J. Poole, resigned.

Mr. Frederic H. Betz has been appointed City Architect of Cleveland, Ohio, at a salary of $2500 per annum. It is announced that hereafter street-cleaning sheds, water towers, sewage- and garbage-disposal plants and all other public works will be designed from an æsthetic as well as a utilitarian standpoint. The City Architect is also to be consulted in the preparation of plans for all bridges erected by the city.

Mr. L. C. Bradley, of Galveston, Tex., has been appointed Assistant District Manager of the Stone & Webster public-service corporations in Texas, with headquarters at Dallas, Tex. Mr. Bradley was formerly Vice-President of the Houston Electric Co. and the Galveston-Houston Electric Ry. and Manager of the Galveston Electric Co. He becomes the executive head of public-service corporations in Galveston, Dallas, Fort Worth, Beaumont, Port Arthur, Houston and El Paso, relieving Mr. M. M. Phinney, District Manager, who will hereafter spend most of his time in Boston, Mass.

Mr. William F. Hunt, Assoc. Am. Soc. M. E., has resigned as First Vice-President of the C. W. Hunt Co., New York City, to enter private practice as a Consulting Engineer, with offices at 115 Broadway, New York City. Mr. Hunt is a graduate of Cornell University and for many years has been in charge of the design, construction and installation of storage and mechanical freight-handling machinery. He will specialize in planning the arrangement of railway and steamship terminals, power plants, factories, etc., and the selection of suitable freight and material-handling apparatus.

Mr. C. A. Seley, Mechanical Engineer of the Chicago, Rock Island & Pacific Ry., has resigned, effective May 1, in order to engage in a manufacturing business. Mr. Seley has been engaged in railway work since 1879, when he entered the employ of the St. Paul, Minnesota & Manitoba Ry. as a draftsman. In 1886 he was made Chief Draftsman of the St. Paul & Duluth R.R. From 1892 to 1895 he was in the railway-supply business, but returned to railway work in March, 1895, as Chief Draftsman of the Chicago Great Western Ry. In 1899 he was appointed Mechanical Engineer of the Norfolk & Western Ry., and in 1902 to the same position with the Chicago, Rock Island & Pacific Ry.

Mr. Mason D. Pratt, M. Am. Soc. C. E., Consulting Engineer, of Harrisburg, Penn., has been appointed Engineer of the United Railways & Electric Co., of Baltimore, Md., under Mr. J. M. Hood, Jr., M. Am. Soc. C. E., Consulting Engineer of the company. Mr. Pratt is a graduate of Lehigh University, class of 1887, and was for several years employed by various Pennsylvania steel companies. He was Designing Engineer on the new mill buildings of the Lorain Steel Co., at Moxham, Penn. Later he was engaged in street railway work at Lancaster, Penn., and municipal engineering work at Dubuque, Iowa. For a number of years he was connected with the street railway and track department of the Pennsylvania Steel Co. Since 1904 he has been in private practice in Harrisburg.

OBITUARY

A. D. Avery, a civil engineer of San Francisco, Calif., died at Sydney, Australia, Feb. 12.

Colin Campbell Simpson, M. Am. Soc. M. E., Assistant Secretary and General Superintendent of Distribution, Consolidated Gas Co., New York City, died at his home in Montclair, N. J., Apr. 7.

Albert G. MacFarlane, Assoc. M. Can. Soc. C. E., District Engineer of the National Transcontinental Ry. of Canada, died in a hotel at Ottawa, Ont., Apr. 4. He was 52 years old and was formerly with the engineering department of the Canadian Northern Ry.

James Doull, Construction Engineer for the W. A. Clark mining interests at Butte, Mont., died at his home in that city on Apr. 6, from pneumonia. He was born at Kincardin, Ont., in 1863. He went to Butte 28 years ago and since then had been identified with construction of numerous mine works owned or controlled by ex-Senator Clark.

Prof. Adolf Slaby, co-inventor of the Slaby-Arco system of wireless telegraphy and teacher of electrical and mechanical engineering at the Institute of Technology in Charlottenburg, Germany, died Apr. 6. He was born in Berlin, Germany, Apr. 18, 1849. Prof. Slaby was the author of many books and articles on electrical engineering subjects. He was also Honorary Professor at the University of Berlin.

Robert Daniel Fisher, for more than a score of years a correspondent of "Engineering News," in Indianapolis, Ind., died Mar. 10. He was born at Amerigus, Ind., Oct. 20, 1849, and in 1881 moved to Indianapolis where he was deputy clerk of the Supreme Court of Indiana, afterward being appointed state librarian, combining with this work that of corresponding for a number of legal and technical journals.

Dr. James A. Egan, Secretary of the Illinois State Board of Health for the past 16 years, died at Springfield, Ill., Mar. 30. He was born in Massachusetts in 1860. In 1887 he went to Chicago and later graduated from the Chicago Medical College. For some time he was connected with the health department of Chicago. In 1897 he was appointed Secretary of the State Board of Health, and in 1901 he became also a member of the board.

Oscar Sanne, Bridge Engineer, Chicago, died at his home at Glen Ellyn, Ill., on Apr. 4. He was at one time in the bridge department of the Chicago, Milwaukee & St. Paul Ry., and later was Structural Designer in the Bridge Department of the city of Chicago. The latter position he resigned a few

months ago to take up private practice. He was specially interested in designing important bridges with due regard to the aesthetic features. He became a member of the Western Society of Engineers in 1898.

Philip H. Diehl, M. Am. Inst. E. E., founder of the Diehl Manufacturing Co., Elizabeth, N. J., died at his home in Elizabeth, Apr. 7, aged 66 years. He was a native of Germany and came to this country in 1868. He was first employed by the Singer Sewing Machine Co., and soon became known as an inventor. In 1879 he invented an electric arc lamp, and later a small battery motor, which embraced the principle of varying the air gap for speed control, and a dynamo. In 1887 he founded the firm of Diehl & Co., which has now become the Diehl Manufacturing Co.

Anton Burchard, a consulting mechanical engineer of Cleveland, Ohio, died Apr. 4, at Ocean View, Va. He was educated in Germany and for some years was employed by William Cramp & Sons, Shipbuilders, of Philadelphia, Penn. Later he was with the construction department of the United States Navy. Mr. Burchard was Consulting Engineer for the American Fork & Hoe Co., the Peck, Stow & Wilcox Co., the Upson Nut Co., the Osborn Manufacturing Co., and other industries in Cleveland. He was a member of the Cleveland Engineers' Club and of the University Club of Cleveland.

Charles E. Pugh, former First Vice-President of the Pennsylvania R.R., died Apr. 8, at Old Point Comfort, Va., following a stroke of apoplexy, on Apr. 6. He was born Feb. 25, 1841, at Uniontown, Penn. At 18 years of age he entered the service of the Pennsylvania R.R. as agent at Newport, Penn. Later he served as passenger conductor, train dispatcher and general agent at Philadelphia, Penn. In 1879 he was appointed General Superintendent of the Pennsylvania R.R., and in 1882 became General Manager. In 1893 he was elected Third Vice-President and four years later Second Vice-President. This position he held for 12 years, being the head of the operating department. Mr. Pugh was elected First Vice-President in 1909, and retired under the company's pension rules on Mar. 1, 1911, after having faithfully served the Pennsylvania R.R. for 52 consecutive years.

Amos D. Caryl, an old-time railway contractor, died Apr. 4, at his farm in Factoryville, Penn., aged 83 years. He was born in St. Lawrence County, N. Y., in 1830, and began his career as a railway contractor at Syracuse, N. Y., when he was 21 years old. Later he went to Scranton, Penn., where he took a contract for the construction of a part of the Delaware, Lackawanna & Western R.R., then being extended from Scranton to Washington, N. J. During the Civil War he served in the construction corps of the army where he found ample opportunity to utilize his knowledge of railway building. After the close of the war he returned to Scranton and continued his work as a contractor on the Delaware, Lackawanna & Western R.R. He afterward held contracts for the building of parts of the Delaware & Hudson R.R., the West Shore R.R. and the New York, Ontario & Western Ry. About 10 years ago he retired and bought himself a farm.

ENGINEERING SOCIETIES

COMING MEETINGS

SOUTHERN GAS ASSOCIATION.
Apr. 18-20. Annual meeting at Charlotte, N. C. Secy., E. D. Brewer, Atlanta, Ga.

NATIONAL GOOD ROADS FEDERATION.
Apr. 24-25. Annual convention. Secy., J. A. Rountree, Birmingham, Ala.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 24-26. Annual convention at Waterloo, owa. Secy., H. E. Weeks, Davenport, Iowa.

NATIONAL CONFERENCE ON CITY PLANNING.
May 5-7. Annual conference at Chicago, Ill. Secy., Flavel Schurtleff, 19 Congress St., Boston, Mass.

GAS, ELECTRIC AND STREET RAILWAY ASSOCIATION OF OKLAHOMA.
May 6-8. Annual convention at Oklahoma City, Okla. Secy., H. V. Bozell, Norman, Okla.

AIR BRAKE ASSOCIATION
May 6-10 Annual convention at St. Louis, Mo. Secy., F. M. Nellis, 53 State St., Boston, Mass.

SOUTHWESTERN WATER WORKS ASSOCIATION.
May 12-14. Annual convention at Ft. Worth, Texas. Secy., E. L. Fulkerson, Waco, Tex.

NATURAL GAS ASSOCIATION OF AMERICA.
May 20-22. Annual meeting at Cleveland, Ohio. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 21-24. Annual meeting at Galveston, Texas. Secy., H. S. Cooper, 405 Slaughter Bldg., Dallas, Texas.

NATIONAL ASSOCIATION OF MANUFACTURERS.
May 19-21. Annual meeting at Detroit, Mich. Secy., G. S. Boudinot, 30 Church St., New York City.

AMERICAN ASSOCIATION OF DEMURRAGE OFFICERS.
Mar. 20-23. Annual meeting at Chicago, Ill. Secy., A. G. Thomason, 834 Old South Bldg., Boston, Mass.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 20-23. Spring meeting at Baltimore, Md. Secy., C. W. Rice, 29 W. 39th St., New York City.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 21-24. Annual meeting at Chicago, Ill. Secy., C. G. Hall, 922 McCormick Bldg., Chicago, Ill.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL, AND STEAM ENGINEERS.
May 22-24. Annual meeting at Springfield, Ohio. Secy., F. E. Sanborn, Columbus, Ohio.

MASTER BOILER MAKERS' ASSOCIATION.
May 26-29. Annual meeting at Chicago, Ill. Secy., Harry V. Vought, 96 Liberty St., New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 2-6. Annual convention at Chicago, Ill. Secy., T. C. Martin, 29 W. 39th St, New York City.

TRAIN DISPATCHERS ASSOCIATION OF AMERICA.
June 7-19. Annual meeting at Los Angeles, Calif. Secy., John F. Mackie, 7122 Stewart Ave., Chicago, Ill.

AMERICAN WATER-WORKS ASSOCIATION.
Annual meeting at Minneapolis, Minn., June 23-28. Secy., J. M. Diven, Troy, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 24-28. Annual convention at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

Brooklyn Engineers' Club—The annual exhibition of engineering materials and processes was held Apr. 15-19.

Montana Society of Engineers—At the annual meeting held in Butte, on Apr. 10, the following officers were elected: President, John H. Klekinger, of Great Falls; Secretary, Clinton H. Moore, of Butte; and Treasurer Samuel Barker, Jr., of Butte.

Canadian Society of Civil Engineers—The offices of the society have been moved from 413 Dorchester St. West, to the Society's new house at 176 Mansfield St., Montreal, Que. The monthly meeting scheduled for Apr. 10 has been postponed to Apr. 24.

County Road Engineers of Kentucky—A convention was held in Louisville, Ky., Apr. 7-9, inclusive, which was attended by about 100 engineers. A. N. Johnson, State Highway Engineer of Illinois, and M. O. Eldridge, of the United States Office of Public Roads, made addresses.

An Association of Purchasing Agents—The formation of a purchasing agents' association, to be known as the Buyers' Club of America is proposed by H. E. Gilman, of the Marathon Motor Works, Nashville, Tenn. It is proposed to have the headquarters of the club in New York. Those interested can obtain further information by addressing Mr. Gilman.

Railway Materials Association—This association is the outgrowth of a meeting of the Railway Storekeepers' Convention held in Milwaukee, Wis., in May, 1911, when some 60 railway supply men met and made arrangements for a permanent organization to be known as the Railway Materials Association. The object of the organization is to promote a friendly interest between the two associations. The annual convention will be held at the Hotel Sherman, Chicago, Ill., May 19-21. The secretary-treasurer is George H. Porter, 1258 McCormick Bldg., Chicago, Ill.

Iowa District Gas Association—The ninth annual meeting will be held at the Burlington Hotel, at Burlington, Iowa, May 7-9, inclusive. Among the papers of interest to engineers to be presented are: "Recent Developments in Industrial Appliances," by E. C. Weisgerber; "Improving Operating Conditions for Small Works," by H. G. Stillson; "Reducing Boiler Fuel in Water-Gas Manufacturing," by T. B. Genay, and "Some Distribution Experiences," by W. H. Merritt. On May 8, the members will go by steamer to Keokuk to inspect the new dam and power plant. The secretary is G. I. Vincent, Des Moines, Iowa.

Associated Engineering Societies of St. Louis—A regular meeting was held on Apr. 2, under the auspices of the St. Louis Section of the American Institute of Electrical Engineers. The paper of Prof. A. S. Langsdorf on "Surges and Oscillations in High Potential Circuits" was read and discussed. The paper dealt with the subject from the physical standpoint, without the use of mathematics. The meanings of current and voltage were described in terms of the electron theory, and the relations between the constants of an electrical circuit were compared with those of corresponding mechanical systems. Conditions were discussed which gave rise to heavy surges of current and power, dangerous rises of potential, traveling and standing waves, and other interesting features of high-power, high-voltage transmission systems.

ENGINEERING LITERATURE

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CORRESPONDENCE

Comments on Review of "Transmission-Line Construction"

Sir—In the Engineering Literature section of your issue of Mar. 13, there is a criticism of Lundquist's "Transmission-Line Construction," in which appears the remarkable statement that Mr. Lundquist in specifying poles by top and butt diameter and length is not following usual practice.

I cannot believe that you intended to make the statement that the type shows but if so, I would suggest consulting the pole specifications of any of the larger companies using poles; for example, the American Telephone & Telegraph Co., Western Union Telegraph Co., or the report of the Committee on Standard Overhead Construction of the National Electric Light Association, or bulletins of the General Electric and Westinghouse companies on line construction, specifications of the various lumber associations, etc. In fact, I cannot now recall ever having seen a pole specification that did not prescribe a butt diameter and as a matter of interest I should appreciate a reference to such specification.

CHARLES RUFUS HARTE,
Asst. Engr., N. Y., N. H. & H. R.R. Co.

New Haven, Conn., March 18, 1913.

[The chance omission of a couple of words from the statement in question leaves it open to the extreme interpretation of our correspondent. It should have read

* * * * * he **always** would specify wood poles according to top and butt diameters and length, whereas it is a common practice to specify length and top diameter only.

Obviously yellow-pine poles, which are sawn and have no natural taper like natural poles, must be specified according to both diameters or by some equivalent scheme. On p. 71 of Mr. Lundquist's book is seen the following paragraph:

In buying poles many companies consider the top diameter only, specifying, for instance, "so many 7-in. top, 35-ft. cedar poles in accordance with the Northwestern Cedarmen's Association Specifications," no mention being made of the butt; this method of purchasing is akin to calling for a 9-in. I-beam, 16 ft. long, without specifying its weight per foot. This "scientific" method of buying poles is not confined altogether to small companies either * * * * *

It is interesting to note that the Specifications of the Committee on Overhead Line Construction of the National Electric Light Association (1911) include such paragraphs as:

When the dimension at the butt is not given, the poles shall be reasonably well proportioned throughout their entire length.

This appears to be in recognition of the claims of those engineers who seem to feel that their interests are better served by omitting butt figures, on account of the growing difficulty of securing wood poles conforming to rigid size specifications.—Ed.]

REVIEWS AND NOTES

A Study of Fuel

Reviewed by WALTER T. RAY*

AN INTRODUCTION TO THE STUDY OF FUEL—A Textbook for Those Entering the Engineering, Chemical and Technical Industries. By F. J. Brislee, D. Sc., Chief Chemist of the British Insulated and Helsby Cables, Ltd.; Late Assistant Lecturer in Physical and Electro-Chemistry in the University of Liverpool. New York: D. Van Nostrand Co. Cloth; 5x9 in.; pp. xxii + 269; 61 text figures. $3, net.

It is seldom one has the pleasure of reading a book so thoroughly practical and so accurately scientific as in this one. The author has pretty well succeeded in his purpose "to bridge the gap that exists between the ordinary elementary textbooks of chemistry, and the large treatises dealing with fuel which enter into minute details of the chemical composition of fuels, the design of coke ovens and producers, and other purely descriptive matter." But there is no royal road to learning, and the student and old practitioner who takes up this book may as well understand on starting that although this book contains exceptionally nourishing food and a great deal of it, the digestion will be a long and difficult process. Prefaces are usually written after their books, and if the reader will follow this order, reading last Guy D. Bengough's preface to the series of books of which this book is one, he will smile; for although it is stated that only a slight acquaintance with chemistry is assumed, nothing is said about physical chemistry.

The scientific use of fuel is by far the over-shadowing problem in applied physical chemistry. This remark need not scare any reader away from this excellent book, for chemistry never was a connected and simple science until the application of physics made it clear. Of recent years combustion engineers have realized that little new light could be shed on their troubles excepting by physical chemistry; this book is the best connected and homogeneous treatise the reviewer has seen.

The first chapter deals clearly with old chemical factors in combustion, and contains paragraphs on reaction velocities, catalysis and dissociation. The second chapter gives much useful information not easily available elsewhere on the weight and volume of air required for combustion, but contains two unfortunate slips. At the bottom of page 21 is this note: "The water is assumed to be in the form of a vapor, and the volume it would occupy at 0° C. and 760 mm., if it could exist as a gas at that temperature, is calculated." Now water vapor does exist below freezing temperature, in one sense, for frozen wet clothes will dry slowly out doors. From a remark at the bottom of page 27 one might get the impression that any carbon monoxide in boiler-flue gases re-

*Clinchfield Fuel Co., Spartanburg, S. C.

sulting from the reduction of carbon dioxide to monoxide by the absorption of carbon is the cause of the loss of more heat than would result from the burning of carbon to carbon monoxide only. The point is that a given mass of the monoxide represents the failure to develop some certain fixed quantity of heat, no matter what the source of the monoxide.

The third chapter is a concise explanation of fuel and flue gas and the fourth treats of the heating value of fuels in a clear but usual way. The next chapter contains a good résumé of present easily available methods for the pyrometric measurement of high temperatures; a useful feature is the table of accurate melting points of easily available substances such as common salt, lead, sulphur, etc. Chapter 6 gives about as simple instructions as possible for calculating theoretical combustion temperatures, a very important subject, for in studying it we see how surprisingly far we fall short of the best performances.

The chapter on natural solid fuels (wood, peat, lignite and various coals) contains nothing especially new, but the information has been carefully grouped. With reference to the chemical classification of coals, some persons might have slightly varying opinions as to what constituted good "bituminous furnace coal," on the analogy that since all whiskey is good to drink all coal is good to burn; but nevertheless the table given is about as satisfactory as could be agreed upon.

Chapter 8 is the best elementary summary the reviewer has seen of the chemical results of coking coals in various kinds of ovens at various temperatures. Much of the information is not easily available in English and it is scattered. An interesting generalization in this chapter is that made from the fact that the calorific value of a fuel as determined in a calorimeter is nearly always different from the value calculated from the ultimate analysis—the generalization being that in order to convert the coal into gas and coke by dry distillation "the heat necessary for the gasifying of the coal is equal to the difference between the heat of formation of the coal and the heat of formation of the products of distillation from their elements." Perhaps this truth can be made plainer by saying that some coals tend to fall down hill into coke and gas, while others have to be pushed up.

On page 157 are given some of the findings of the United States Geological Survey as to the comparative performances of briquettes and run-of-mine coal; part of these findings were later reversed by tests made by the same Survey, which goes to show that the matter is more complicated than was at first thought. These latter tests are given in a bulletin of the United States Bureau of Mines named "Tests of Briquetted and Run-of-Mine Coal in a Locomotive Boiler."

The ninth chapter is a good exposition of the chemical reactions taking place in a gas producer, especially as to how these reactions are affected by different temperatures and different velocities of the gases through fuel bed. It is made plain that relatively slight elevations of temperature of the fuel bed result in a surprisingly large increase in the amount of air and steam which can be blown through a producer, still getting out the same composition of gas. Probably the best work which has been done in laboratory investigations of this subject was done by J. K. Clement and others at the University of Illinois and in the fuel-testing plant of the U. S. Bureau of Mines, at Pittsburgh, Penn.; but unfortunately the commercial bearing of their work still awaits translation into engineering English. Application of these physico-chemical principles may yet result in making the gas producer available for large power-plant work through reducing the heavy fixed charges and heavy labor costs. When gas producers are thus worked at high temperatures and high outputs, the consequential liquefaction and draining out of the ash of the coal will be a merely incidental advantage.

The two following chapters treat of the construction and operation of producers and of the theory of producer- and water-gas reactions by means of higher mathematics. The mathematical discussion cannot well be reviewed, but its detailed perusal will richly repay any student.

Chapter 12 applies some physical chemistry to the gas engine in an instructive way. Chapter 13 treats of air supply, the measurement of "draft," etc., in a clear way, but one cannot but wonder why the author went into such mathematical depths in some preceding chapters and did not avail himself, for the sake of his readers, of some recent simplifications of the puzzling and mysterious subject of drafts, as is done in some of the publications of the U. S. Bureau of Mines.

The two chapters which follow treat clearly but conventionally of heat generation and the various furnace and boiler losses and the final chapter treats of liquid fuels, giving on page 254 a good classification of the various petroleums, coal tars, etc.

The book as a whole is a good one.

Mechanics

Reviewed by H. T. EDDY*

RATIONAL AND APPLIED MECHANICS—By Calvin Milton Woodward, Ex-Dean of School of Engineering and Architecture; Professor Emeritus of Mathematics and Applied Mechanics, Washington University, St. Louis, Mo. St. Louis: The Author, 3013 Hawthorne Boulevard, or Nixon-Jones Printing Co., 215 Pine St. Cloth; 6x9 in.; pp viii + 517; 486 text illustrations. $4.

This textbook is the work of an able teacher of unusually long and varied experience in giving instruction in this central and fundamental subject of engineering education, and in dealing with its theoretical aspects.

The treatise is an excellent one, well arranged and well written. As was to be expected and as it should be, it exhibits on the part of the author an ever present sense of the physical reality and actual relations of the structures and materials under investigation, such as the would-be engineer needs to have instilled into his consciousness. It is a good book and so thought out in its developments as to render the presentation of the various theoretical developments easy to grasp, by joining them closely to the range of experience already familiar to the student and by making rather intricate and abstruse principles appear reasonable to his relatively untutored apprehension. Having gladly conceded all this, the reviewer must claim the privilege of all teachers to disagree with the author as to the general idea underlying his book, respecting the field which such a book should be designed to fill.

The subject of Mechanics in all its branches is the one that affords the undergraduate engineering student more difficulty in its mastery than perhaps all other subjects together. This is the common experience alike of faculty and student, and it behooves those who arrange the curriculum and administer the work of an engineer to see to it that every care be exercised to smooth the way to the mastery of this essential basis of all engineering design. One of the first requisites seems to be to separate the difficulties inherent in mechanical principles from those of the mathematics employed, as well as from the application of those principles sufficiently to bring it about that they be met and mastered successively and not attempted all at once.

The most successful way of doing this that has come to the attention of the present writer is to have the student take a course in elementary mechanics, beginning in his freshman year, or sooner, in which no calculus or analytical geometry shall be used, but which shall treat the simpler ideas of mechanics in great detail by the numerical solution of so large a number of problems in application of these principles as to really cultivate an engineering sense of the reality of the objects treated by this form of applied mathematics. This should be followed in the sophomore year by the mastery of the methods and processes of calculus.

The attempt to take up the more advanced mechanics by calculus methods during this time is certain to greatly increase the difficulties of mechanics, not merely by adding those of calculus to those of mechanics, but more nearly by multiplying those of mechanics by those of calculus. The work in advanced engineering mechanics should be deferred until the junior year when such due mathematical preparation would have been made by the student that it would then be possible for him to study for use the very professional books he would wish to use in after life.

Now this text of Dr. Woodward's is written to be studied in the sophomore year during the time the student is engaged in mastering calculus. It is not the intention of the author that it shall be the student's direct basis and reference book for professional work, but that he shall depend upon more advanced treatises for that. And yet the author hopes that no teacher will attempt to rush a class through the work in any period of forty weeks. That is practically a year's work. How much time should a student spend on a confessedly preliminary or secondary text?

It is possibly the idea of the author that this treatise gives all the training in applied mechanics needed by an undergraduate. With that view of the question the present reviewer cannot agree, especially as the text is almost entirely didactic and illustrative. It would seem to him that any text in applied mechanics at all adequate for embryo engineers should embody such applications in the shape of problems to be worked as are not mere illustrations, but of such wider scope that the student after solving them and arriving at results indicated in the text could be certain that he understands how to apply the principles and formulas of the text. The author says he has not cared to multiply problems. He has not done so, and it would seem to the re-

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viewer that he perhaps has done wisely in view of the degree of maturity, or rather immaturity, of the student for whom the book is primarily intended.

Applied Mechanics would seem to be a professional subject, and one to be attempted at a time when the student feels that he is actually entering upon professional studies in applying theories and principles to actual or assumed structures and materials. Most of the standard textbooks on that subject today are written from that standpoint. It may not be the correct point of view. Nevertheless the present reviewer subscribes to it, and from that point of view alone offers the foregoing criticism of this textbook.

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Part II of Unwin's and Mellanby's "Machine Design"

Reviewed By JOHN J. FLATHER*

THE ELEMENTS OF MACHINE DESIGN—Part II. Chiefly on Engine Details. By W. Cawthorne Unwin, F. R. S., LL. D., Formerly Professor of Engineering at the Central Technical College, and Professor of Hydraulic and Mechanical Engineering at the Royal Indian Engineering College, and A. L. Mellanby, D. Sc., Professor of Engineering at the Royal Technical College, Glasgow. New and revised edition. New York, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5½x9 in.; pp. xxiii+422; 311 illustrations in text. $2.50.

For the past quarter century students of engineering and practicing engineers and draftsmen have been using Unwin's textbooks of Machine Design. The present volume is a revision of Part II, first published as a separate volume in 1891 and revised in 1902. It deals chiefly, although not exclusively, with steam-engine details, arranged in definitely related groups embracing most of the mechanical problems which occur in machinery for generating power; problems which, on the whole, are more complex than those discussed in Part I (reviewed in these columns Jan. 13, 1910). In Part I the general phenomena of the strength of materials and the laws affecting straining actions are considered; but in the various cases to which these laws are applied the straining actions are usually statical or may be treated as such. On the other hand, in the design of transmissive machinery, both strength and kinematic relations are involved. In the design of machines which are intended to supply mechanical energy for doing work, the members are subjected to varying forces and move at various speeds which produce stresses best determined by the application of dynamical principles—the present treatise is devoted chiefly to a consideration of these problems.

In the revision before us Prof. Unwin has delegated the main responsibility for the additions and modifications to Prof. Mellanby, an engineer especially well qualified for the work, both by experience and technical training. Over one hundred new illustrations have been added and much new material has been presented throughout the book. The chapters on governors and condensers have been written for this edition and other parts have been rewritten.

A treatise such as this serves a two-fold purpose: (1) It consists in part of a collection of designs, data and rules for use in the drafting office; but it is not merely a collection of designs from which rules of thumb have been deduced for the use of the designer; rather it consists of the application of scientific principles to examples in practice from which simple rules have been deduced in the less complicated instances. Where the conditions are not exactly amenable to theory, or are too indefinite for exact determination, the limitations are indicated, and the practical engineer must draw upon his experience guided by the limitations suggested. (2) The other purpose of such a treatise is to serve as a textbook for engineering students and others. The practical problems presented and their discussion from a theoretical standpoint is of great value in familiarizing the student with the requirements involved in machine construction, and the considerations which guide an engineer both indirectly and empirically in designing machines. A critical examination of the present text shows that the latter purpose has been kept prominently in the foreground and many of the problems are worked out systematically and in detail, from the viewpoint of the teacher of engineering students.

The captions of the 19 chapters forming the book indicate the character and scope of the work under review:

On Pipes and Cylinders; Arrangement and Proportions of Steam Engine Cylinders; Indicator Diagrams; On Some Kinematical and Dynamical Problems in Engine Designing; Balancing; Cranks, Levers and Eccentrics; Pistons and Piston Rods; Connecting Rods; Crossheads and Slides; Stuffing Boxes; Flywheels; The Steam Engine Governor; Valves, Cocks and Sliding Valves; Condensers; Steam Engine Valves; Valve Diagrams; Expansion Valves; Link Motions and Reversing Gears; Lubricators.

As will be noted, the topics treated cover the field of steam-engine design very fully but it is to be regretted that the limitations imposed by the requirements of a handy textbook have led to omissions which the present reviewer would prefer to have seen incorporated in the text. Notably among these is the entire absence of any consideration of shaft governors. Ten pages of new material are devoted to governors but the entire discussion is given over to ball or pendulum governors.

As would be expected, the illustrations of constructive details relate almost entirely to English practice, but this is not a serious objection to the American designer; rather it is an advantage in illustrating foreign construction. The fact that the proportions indicated are based on sound theoretical principles, modified as required by practical considerations, must appeal both to the student and designing engineer.

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Clark's Gas Engines Revised

THE GAS, PETROL AND OIL ENGINE—Vol II, The Gas, Petrol and Oil Engine in Practice. By Dugald Clerk, M. Inst. C. E., and G. A. Burls, M. Inst. C. E. New and revised edition. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. vii+838; 481 text figures. $7.50, net.

It is 26 years since Dugald Clerk's treatise on the gas engine was first puslished. A second edition, largely rewritten, was published in 1896. Since that time a technical and commercial development of the internal combustion motor has occurred far exceeding all that had taken place previously.

For a number of years Mr. Clerk has been engaged in rewriting his treatise and it is now published in two volumes, the first of which appeared four years ago, and was devoted to a general study of the internal combustion engine, its theory, thermodynamics, etc. The second volume now issued deals with the practical problems of design, construction and operation of internal combustion engines and is nearly twice as bulky as Volume I. G. A. Burls, M. Inst. C. E., who was formerly associated with Prof. Unwin, has assisted Mr. Clerk in the preparation of this second volume.

Mr. Clerk's first treatise was devoted to the gas engine and while the second and the present editions include matter on gasoline and oil engines, the gas engine still receives chief attention. The first two very long chapters, with a combined length of over 250 pages, are devoted respectively to the development of four-stroke cycle gas engines and of two-stroke cycle gas engines. Curiously enough, the author refers to the former as "the four-stroke cycle" and the latter as "the two-cycle" engine.

Notwithstanding the large space given to this subject, one looks in vain in these two chapters for any such concise and clear statement of the relative advantages of the four-stroke cycle and the two-stroke cycle as is given for instance in Güldner's well known work.

Much space in Clerk's chapter on two-cycle engines is given to descriptions of his own early work and of such curiosities as the old Atkinson engine, material which is now of only historical value. In this chapter, and also throughout the book, large space is given to detailed reports of tests of engines, most of which have little significance at the present time. Some criticism must be made also of the classification adopted by the author in treating the subjects of "petrol (or gasoline) engines," of "heavy oil engines" and of "marine engines," each in separate chapters. Anything on two-stroke cycle engines contained in these chapters is not included under the two-stroke cycle gas engines in Chapter 2. We do not find that the author has anywhere described the notable two-stroke cycle engine developed by Junkers, in Germany, and considerable of the work of prominent Continental builders of Diesel engines, which has attracted wide attention during the last few years, finds no mention here.

Among the other subjects to which special chapters are devoted we may mention the following: Igniting Arrangements; Speed Regulation; Gas and Fuels; Petroleum, Petrol and Paraffin Oils; Carburetors. The concluding chapter is devoted to the future of internal combustion motors.

Notwithstanding the above minor criticisms with reference to scope, arrangement and treatment, the book represents an enormous amount of labor in collection and compilation; and it will continue to rank as a standard work on internal combustion engines. The distinguished author of the book is undoubtedly among the most prominent of English engineers who have contributed to the present development of the internal combustion engine. His book bears testimony both to his industry and his ability.

Psychological Engineering

PSYCHOLOGY AND INDUSTRIAL EFFICIENCY—By Hugo Münsterberg. Boston and New York: Houghton-Mifflin Co. Cloth; 5x8 in.; pp. 315. $1.50, net.

Such of the efficiency engineers as are really engineers know that to attain success in a shop or factory they must master the laws governing the action of machines. Only a few of these engineers seem to realize that it is equally necessary for them to understand the action of the human mind. This lack is in large measure excusable, for it is not long that the science of the mind has been much more than a pure abstraction. Quite recently, thanks to a most practical broadening of the work of the modern psychological laboratories, psychical studies have been combined with physical studies of man and still more recently these psychophysical studies have been practically applied to the solution of a number of grave industrial problems.

It does not seem too much to say that we are now on the eve, if not at the dawning, of a great industrial era—the psycho-technical. The best of the efficiency engineers have pointed the way toward this era, though mostly by intuitional and cut-and-try methods; the mediocre efficiency engineers and the sheer imposters (who together far outnumber the real efficiency engineers) have done much, with their high-sounding generalities and ridiculous claims, to befog the way and to lead the more intelligent, but as yet ill-informed public to believe that most of the current "efficiency" talk is pure gammon.

Prof. Hugo Münsterberg, of Harvard University, seems to have done more than any other one man to prepare the way for the psycho-technic era. His first book on the application of psychology to industrial problems was published in 1912, with the title "Psychologie und Wirtschaftsleben: Ein Beitrag zur angewandten Experimental-Psychologie" (Leipzig: J. A. Barth). This was soon followed by the volume now before us, "which is not a translation," the author says, "as some parts of the German volume have been entirely omitted and other parts have been enlarged and supplemented. Yet the essential substance of the two books is the same."

No one interested in human or industrial efficiency should be kept away from this book by fear that its pages abound in technical terms beyond their understanding, for the book is notably free from technicalities.

After a short Introduction the author devotes about a hundred pages each to The Best Possible Man and to The Best Possible Work, which form Parts I and II of the book. In Part I chapters on Vocation and Fitness, Scientific Vocational Guidance and Scientific Management are followed by one on The Methods of Experimental Psychology. This leads up to three chapters which detail some interesting psychological experiments made by the author in the interests of the electric railway, ship and telephone services. These chapters are forcible illustrations of the aid which the science of the mind can render to the industrial arts. Other chapters in Part I give some experiences and opinions of men of affairs as to the human efficiency problems and discuss individual and group differences.

Part II, The Best Possible Work, takes up still other practical problems, such as The Adjustment of Technical to Psychical Conditions, motion, monotony and attention and fatigue studies. A more general subject is Physical and Social Influences on the Working Power.

The third and final Part, The Best Possible Effect, has as its text the idea that even the best man and the best work combined may not give the highest economic results, unless they are utilized for The Satisfaction of Economic Demands. After this opening chapter the author seems to wander somewhat from both the text just mentioned and the general subject of his book, although there is some warrant for including in this volume accounts of experiments on the effects of advertisements and on illegal imitation, as well as a chapter on Buying and Selling.

The closing chapter, on The Future Development of Economic Psychology, is brief but interesting and suggestive. The author had previously spoken of the "consulting economic psychologist." We quote a few sentences as to the training of industrial psychologists and the possible uses which could be made of them and of what Prof. Münsterberg even goes so far in one instance as to call psychological engineers.

> Experimental workshops could be created which are really adjusted to the special practical needs and to which a sufficiently large number of persons could be drawn for the systematic researches. The ideal solution for the United States would be a governmental bureau for applied psychology, with special reference to the psychology of commerce and industry, similar to the model agricultural stations all over the land under the Department of Agriculture. . . . .
>
> There are many factories that have scores of scientifically trained chemists or physicists at work, but who would consider it an unproductive luxury to appoint a scientifically schooled experimental psychologist to their staff. And yet his observations and researches might become economically the most important factor. Similar expectations might be justified for the large department stores and especially for the big transportation companies. In smaller dimensions the same real needs exist in the ordinary workshop and store. It is obvious that the professional consulting psychologist would satisfy these needs most directly, and if such a new group of engineers were to enter into industrial life, very soon a further specialization might be expected. Some of these psychological engineers would devote themselves to the problems of vocational selection and appointment; others would specialize on questions of advertisement and display and propaganda; a third group on problems of fatigue, efficiency and recreation; a fourth on the psychological demands for the arrangement of the machines; and every day would give rise to new divisions. Such a well-schooled specialist, if he spent a few hours in a workshop or a few days in a factory, could submit propositions which might refer exclusively to the psychological factors and yet which might be more important for the earning and the profit of the establishment than the mere buying of new machines or the mere increase in the number of laborers.
>
> No one can deny that such a transition must be burdened with difficult complications and even with dangers; and still less will anyone doubt that it may be caricatured. One who demands that a chauffeur or a motorman of an electric railway be examined as to his psychical abilities by systematic psychological methods, so that accidents may be avoided, does not necessarily demand that a congressman or a cabinet minister or a candidate for marriage be tested too by psychological laboratory experiments, as the witty ones have proposed. And one who believes that the work in the factory ought to be studied with reference to the smallest possible expenditure of psychical impulses is not convinced that the same experimental methods will be necessary for the functions of eating and drinking and love-making, as has been suggested.

That our author has no lack of common sense and that still rarer quality, a sense of humor, is shown by the last paragraph of our quotation.

Such a book as this should make an appeal to a large proportion of our readers for it has a message for everyone interested in either industrial or human efficiency, even though its human efficiency message may chiefly concern one's own self.

ELEMENTS OF WESTERN WATER LAW—By A. E. Chandler, Irrigation and Water Right Specialist; Assistant Professor, Irrigation Institutions, University of California; Secretary, American Engineering Corporation, San Francisco. San Francisco: Technical Publishing Co. Cloth; 5x9 in.; pp. 150. $2.

Water law in those parts of the western United States where irrigation is paramount follows the doctrine of prior appropriation for beneficial use as contrasted with the riparian rights doctrine of the eastern United States and of England. In the semi-arid region the riparian principle controls to a greater or less extent.

The volume before us reviews the history and present status of both the doctrines named, as regards the western states, citing decisions and summarizing legislation. Such subjects as water rights on interstate streams, rights-of-way over public lands, commercial irrigation enterprises, the Carey and Reclamation acts and irrigation districts are also treated.

It is interesting to note that 13 states have passed legislation authorizing irrigation districts, although only nine had district projects completed or under construction in 1910, while most of the land under water in such districts was located in California, Colorado, Idaho and Nebraska.

The book is an abbreviation of part of a course of lectures given by the author to advanced students of agriculture and civil engineering at the University of California. Its contents have previously appeared in the "Journal of Electricity, Power and Gas."

SEWAGE POLLUTION OF INTERSTATE AND INTERNATIONAL WATERS, with Special Reference to the Spread of Typhoid Fever—By Allan J. McLaughlin. Hygienic Laboratory Bulletin 83, Public Health and Marine-Hospital Service of the United States. Paper; 6x9 in.; pp. 296; 91 charts in text and 32 maps.

After an interesting and instructive comparison of typhoid-fever rates in the United States and in Europe and a further study of typhoid fever, enteritis and infant mortality as related to water-supply in the United States, the author presents the results of a survey of water pollution and typhoid in the cities on the four Great Lakes and their connecting or outlet rivers, as named in the sub-title. Tables, diagrams and maps are freely used. The conclusions drawn are that much more attention should be paid to the purification of the water-supplies of the cities on these interstate waters, and that water purification should take precedence over sewage treatment. An earlier report dealt with Lake Erie. The author deserves commendation for his sane views on the relation betwen sewage disposal, water pollution, water purification and sewage treatment.

The Framework of American City Government

THE GOVERNMENT OF AMERICAN CITIES—By William Bennett Munro, Ph. D., Professor of Municipal Government, Harvard University. New York: The Macmillan Co. Cloth; 5¾x9 in.; pp. 401. $2, net.

It is a striking fact that of the many books on municipal government published in the last dozen years nearly all deal with the framework, machinery, or organization of cities and few with administration or operation. This is directly in line with the American tendency to work reforms through legislation rather than through administration. When reforms in administration are attempted they generally stop short with a change in the machinery of putting men into and out of office or at most with the displacement of one set of men selected with little or no regard for fitness by another set chosen in the same way, both alike being subjected to no real control which will insure efficient public service.

Prof. Munro, in the book before us, has purposely limited himself to the "framework" rather than "the functioning mechanism of the municipal organization," but we are glad to note that he proposes "to deal fully" with administration in a later volume. Within the limits set the author has produced a useful book—a fit companion to his excellent "The Government of American Cities" (noticed in these columns May 13, 1909).

After reviewing the history and social structure of the American city and its relation to its creator (and sometime destroyer), the state, the author takes up in succession the powers and responsibilities of cities, the electorate and its actions through nominations and elections, and then municipal parties and politics. This brings the reader to the human machinery of government, selected by the voters or their bosses, as embodied in the mayor, the council, and the various administrative departments. The personnel is then taken up more specifically in a chapter on "Municipal Officials and Employees." Chapters follow on the commission plan, the initiative, the referendum and the recall, and finally a well pointed chapter on "Municipal Reform and Reformers," which is one of the best in the book.

The general plan followed is first to present the chapter subject in a historical and descriptive manner, and then, where conditions warrant it, to sum up the advantages and disadvantages of rival plans, such as administrative boards as against single commissioners, the commission plan compared with the independent mayor and council and direct legislation as opposed to legislation by a representative body. The treatment is judicial, although the author does not hesitate to approve or to disapprove where, in his judgment, reason and experience are conclusive one way or the other.

As is almost inevitable in a book of so wide a range, not all the data given are uptodate. A minor lapse is the inclusion of Pittsburgh with cities having a bi-cameral council. A more notable deficiency and one which might easily have been avoided occurs on page 40, where death rates by five-year periods are given for New York, Chicago, Philadelphia and Boston, ending with 1901-5. While this table serves to illustrate the declining urban death rate, it could have been made still more striking by adding the period 1906-10, and the single year, 1911. This omission is not so important, however, as the over emphasis placed upon the low death rate of rural as compared with urban communities. The author says:

> The city, as is well known, has a death rate per thousand very much above that of the country, a social phenomenon which seems to have held true in all periods and in all countries.

Although the context, as well as the table just mentioned, shows the rapid decline in the urban death rate in the past three decades the author does not point out the very significant fact that the urban death rate has declined and is declining more rapidly than is the rural. This disparity would be all the more marked, it seems certain, if the line between urban and rural (placed by the U. S. Census at 8000 population) were raised so as to come more nearly to the real dividing line between communities which have and those which have not been benefited by those "enormous advances made by" medicine, sanitation, personal hygiene and "preventive medical science generally," which the author notes as instruments in reducing the urban death rate. The rural districts and a large percentage of the population in the smaller and even in many of the middle-class cities have the benefit of relatively few of these advantages. Moreover, the rural districts and the smaller cities by their health-protective deficiencies are actually retarding the remarkable fall in the death rates of the more progressive cities, large and small.

A questionable line of argument is advanced (page 255) in support of administrative boards as against single commissioners, on the score of economy. While this argument is in qualified terms and is limited somewhat to the smaller cities, yet it is not so full a presentation of both sides of the case as the author generally gives. It should perhaps be added that the author assumes that these boards would serve without pay and that under them there would be well qualified subordinates chosen by the merit system. Of course the real test, as the author would himself say, had he carried the discussion further, is the relative efficiency of the board and of the single commissioner plan, rather than the salary drain upon the city treasury.

Finally, although Prof. Munro's book does not claim to add materially to the mere volume of data of municipal government, yet it does bring many of the later data together in convenient and readable form, interprets and weighs these data and draws from them many valuable deductions. As we have already intimated, the volume well complements the author's earlier work on "The Government of American Cities." There remains now for him the task of producing his third volume, on municipal administration; a work, as may be inferred from our opening paragraph, more needed than was another volume on the framework or machinery of municipal government, welcome as the present volume is, and much more difficult to produce without falling into many errors of commission. If Prof. Munro succeeds in his third task, as we have no doubt will prove to be the case, he will indeed have produced a remarkable trilogy in municipal literature.

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Revision of Webb's "Railroad Construction Economics"

Reviewed by WALTER W. COLPITTS*

THE ECONOMICS OF RAILROAD CONSTRUCTION—By Walter Loring Webb, M. Am. Soc. C. E., Assistant Professor of Civil Engineering (Railroad Engineering), University of Pennsylvania, 1893-1901. Second edition, thoroughly revised. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. viii + 347; 34 text figures. $2.50 (10/6), net.

The first edition of this work, which appeared in 1906 and was noticed at length by the writer of this note in "Engineering News" of April 18, 1907, was regarded as an excellent epitome of a subject that covers a very wide range. The need for an authoritative statement of the correct value of the economic factors upon which a scientifically designed railroad should be based was felt by all engineers, and this need has been supplied in a marked degree by Professor Webb's book. The new edition brings the data comprised in the tables and diagrams down to date and adds new material on matters that have been subjects for experimentation since the publication of the first edition.

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A STUDY OF IOWA POPULATION AS RELATED TO INDUSTRIAL CONDITIONS—John E. Brindley, A. M., Ph. D., Associate Professor of Economics and Political Science. Bulletin 27, Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa. Paper; 5¾x8¾ in.; pp. 64; 4 folding charts.

After presenting studies of Iowa population from 1840 to 1910 and discussing the "Causes and Remedies of a Declining Population" (illustrated by graphical freight-rate data) the author draws a series of conclusions of particular interest to engineers. He recommends an extension of the instruction already offered by the state in the way of higher technical education, including research work; "Secondary instruction in the industrial and mechanic arts" for "the many rather than the few"; a survey of the natural resources of the state; and various reforms in legislation. The final conclusion is that an Engineering Extension Division should be added to the Engineering College at Ames, to render ser- Agricultural Extension Division.

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A little manual of first aid in electrical accidents ("Electrical Injuries," by C. A. Lauffer, M. D.; John Wiley & Sons; 50c., net) has been prepared by the medical director of the Westinghouse Electric company. It is a simple discussion of the effects of shocks and burns, principally, and of the immediate measures that must be taken if life is to be saved or intense suffering alleviated. Therefore it should be read by everyone who is likely to face such situations in the shop or field. The book explains the utility and simplicity of the "prone pressure" (Schaefer) method of resuscitation, which a joint commission of doctors and engineers has recommended as superior to the older Sylvester movements.

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An Elementary Text on Steam Engineering

Reviewed by WINSLOW H. HERSCHEL*

STEAM ENGINEERING—A Text book. By William R. King, U. S. N., Retired; Principal, Baltimore Polytechnic Institute. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. vii + 450; 177 illustrations. $4, net.

No book of 439 pages could possibly cover all forms of apparatus connected with the use of steam. Therefore it is not surprising to find the less common subjects, such as chimney design, feed water purifiers, refrigeration and air compressors omitted from the volume before us. Nor is it to be expected that the treatment of the apparatus considered should be exhaustive. The steam turbine suffers most through lack of completeness, though the latest developments of this important prime mover are as well brought out as could be done in 32 pages.

Thus the book is mainly an elementary textbook on the steam boiler, reciprocating engine and accessories, including among the latter, feed water heaters, pumps, economizers, injectors, condensers and other appliances. The main idea of the book is to present the subject with such simple but complete explanations in regard to the thermodynamics and kinematics involved that the student will not need to have previously studied these subjects. A knowledge of calculus is not absolutely necessary, as very sparing use is made of it. In Chapter X, on Expansion of Gases, the integration sign is used only seven times, and in Chapter XIII, on the Carnot Cycle, it is used but twice. Those who have suffered under Rankine and his followers will appreciate what a marked innovation this is for a book on thermodynamics.

A few points might be noted which could cause trouble to the student. On page 5 it does not seem to be clearly enough stated that "V" in thermodynamics always means the volume per pound, and not the total volume that happens to be considered in a problem.

If the formula for "I.HP." on page 240 were written without the "2" and "N" defined as the number of power strokes per minute, there would be less danger of confusion in applying the formula to two-and four-stroke-cycle gas engines and single-acting steam engines.

The author has used the Marks & Davis steam tables in all but the first two chapters of the book, and might better have used them throughout. The reviewer believes it would have been preferable to have gone farther and eliminated all data and formulas not in accord with the most recent determination of the properties of steam, as for example the value of 0.48 given on page 297 for the specific heat of superheated steam, and the formula given on page 20 showing the relation between pressure and volume of saturated steam: "$p v^{\frac{17}{14}} = 482$."

As regards simplicity of treatment and sequence of subjects the author has been most successful. The book might be used to advantage either in a short course where time was limited, or in a longer course with the idea of taking up the subject more fully later on. This latter method would have great advantages over the usual practice, because when an advanced text of thermodynamics is used, the subject is notoriously distasteful to the student, who realizes only that he has encountered a difficult course about the practical value of which he has the gravest doubts. If the student approached the subject as in Steam Engineering, learning the thermodynamics no faster than was necessary to explain the construction of the apparatus considered, he would be sure to regard a subsequent course in advanced thermodynamics in an entirely new light.

ANLEITUNG ZUR DURCHFUEHRUNG VON VERSUCHEN AN DAMPFMASCHINEN, DAMPFKESSELN, DAMPFTURBINEN UND DIESELMASCHINEN—Zugleich Hilfsbuch für den Unterricht in Maschinenlaboratorien technischer Lehranstalten. By Franz Seufert, Ingenieur, Oberlehrer an der Kgl. höheren Maschinenbauschule zu Stettin. Third edition. Berlin: Julius Springer. Flexible linen; 5x8 in.; pp. vii + 105; 43 text illustrations. 2.20 marks.

As indicated by the complete title of Mr. Seufert's German work, his book is not a compilation of the results of tests, but a very elementary handbook for use in mechanical laboratories and by testing engineers. Of the subjects mentioned, testing steam engines occupies 55 pages; steam boilers, half as much; while Diesel engines are treated in 16 pages. In the five pages devoted to steam turbines, very little is contained that would not apply equally well to steam engines. For steam or Diesel engines, the objects of a test are said to be the determination of indicated horsepower, brake horsepower and consumption of heat units per horsepower-hour. In addition, under steam engines, water rate and valve setting are considered, and under Diesel engines, the consumption of combustible.

It is evident from the section on boilers, that here the German code is unlike the American. The weight of water evaporated per hour, per unit area of heating surface and per unit area of grate are determined, together with the ratio of weight of steam to weight of coal, both under actual conditions of test and reduced to "normal steam." Normal conditions are not, however, from and at 212° F., but steam is supposed to be generated at atmospheric pressure from feed water at a temperature of 32° F. The method of finding the calorific value of fuels is considered, and the indicator, Prony brake, Orsat apparatus, draft gage and Ringelmann's smoke chart are described with illustrations.

Besides giving instructions for carrying out tests, the author pays some attention to the interpretation of results, and in this connection gives a page to defective indicator diagrams and explains how the valve setting should be changed in each case. That the book fills a certain need for those who do not desire a more comprehensive work, is shown by the fact that it appeared in 1906, has been translated into Russian, and is already in its third German edition.

AMERICAN MINE ACCOUNTING—Methods and Forms Employed by Leading Mining Companies. By W. H. Charlton, P. A., Member, Lake Superior Mining Institute. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. viii + 367; 250 text figures. $5, net.

In his preface, the author states that he has had twelve years' experience as an accountant with various copper-mining companies in the Lake Superior district, and that in this capacity he has felt the need of a technical work on mine accounting.

The book he has given us is a compilation of material, including specimens of a great many blank forms, which illustrate in detail the practical working systems of companies representative in their particular fields of mining.

The book is divided into six chapters: The first on mining iron ore, which gives the practice of the Oliver Iron Mining Co.; the second on mining and milling native copper and the practice of the Ojibway Mining Co.; the third on mining copper ore, Utah Consolidated Mining Co., and smelting copper ore, Calumet & Arizona Mining Co.; the fourth on mining coal and making coke, Utah Fuel Co.; the fourth on mining and milling gold ore, the Portland Gold Mining Co.; and the last chapter deals with various mehods of recording engineering and geological data.

The text consists of straightforward explanations of the selected practice and of the use of the forms illustrated. In general, theoretical discussions are avoided. The typography and illustrations are excellent, and show much painstaking work.

The definitions, descriptions and explanations give a great deal of information on mine management and operation, as well as on mine accounting. A mining library could hardly be considered complete without such a reference work, although the average mining engineer may not care to master the principles of mine accounting.

SMALL WATER SUPPLIES—Being a Practical Treatise on the Methods of Collecting, Storing and Conveying Water for Domestic Use in Large Country Mansions, Estates and Small Villages and Farms, for the Use of Engineers, Estate Agents and Owners of Country Property. By F. Noel Taylor, C. E.; Member of the Institute of Municipal Engineers; Author of "A Manual of Civil Engineering Practice." London: B. T. Batsford. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. vii + 174; 126 text illustrations. $2, net.

Water-supply and water-works for country houses and estates, while involving no very intricate engineering problems, is to some extent a specialty for which there is a good excuse for a textbook. While there is little in Mr. Taylor's book which an engineer is not supposed to be acquainted with, or at least could find in other words in his library on hydraulics and engineering construction, it does give in concise form the parts of those subjects of most value to the builder of a small water-works system. Indeed the book is not written for engineers only, but for estate agents and owners of country property.

The subject matter is clearly and logically presented, beginning with a discussion of water, its impurities, testing and treatment; the various sources of water-supply, treating particularly the sources of small supplies, such as wells and springs; the flow of water in channels and pipes, and the meas-

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urement of water by weirs. There is an excellent chapter on small pumps and power-generating devices, including the hydraulic ram, gasoline engine and windmill. The chapter on storage and distribution gives enough of the principles of dam and masonry construction to aid in the building of small reservoirs, storage tanks and water filters.

The book is sufficiently technical to furnish the engineer with standard formulas and working data and yet is popular enough to be of real service to the average estate owner; if not in designing a water-works system, at least in preventing his making radical errors in selecting the source of supply and distribution equipment.

Alternating-Current Generators, Motors and Converters

Reviewed By B. A. BEHREND*

DESIGN OF POLYPHASE GENERATORS AND MOTORS—By Henry M. Hobart, M. Inst. C. E., Consulting Engineer, General Electric Co. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. viii+265; 125 text figures. $3, net.

SYNCHRONOUS MOTORS AND CONVERTERS: Theory and Methods of Calculation and Testing—By André E. Blondel, Hon. M. Am. Inst. E. E., Professor in National School of Bridges and Highways of France. Translated from the French by C. O. Mailloux, Consulting Electrical Engineer, with additional chapters by Comfort A. Adams, Professor of Electrical Engineering in Harvard University. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xviii+295; 148 text illustrations. $3, net.

Mr. Hobart has written a most useful treatise. It is fortunate that he can bring to his task the erudition of a scholar and the experience of an engineer trained both in Europe and in the United States. He thus happily avoids the Scylla of academic treatment as well as the Charybdis of crude practical empiricism, and he steers his course between these perils in a most successful manner. The reader is taken through the simple fundamentals of the design of alternating-current machinery by being shown how to arrive at the number of poles, and at the approximate size of a machine by figuring the output coefficient and the ampere conductors per inch of periphery—called by the author the "peripheral loading." The dimensions of the slots, the space factor, and the insulation, as well as the general distribution of windings, are simply and lucidly discussed and are illustrated by good diagrams. Then follows the design of the magnetic circuit, in which the author shows how to dimension the different parts and how to compute the magneto-motive forces which are plotted in the saturation curve. The regulation of alternating-current generators is then discussed and the principles of design are illustrated by a complete calculation of a 2500-kv.a. generator.

Turbo generators are somewhat superficially adverted to in chapters on generators with distributed field windings. Subsequent chapters deal with the squirrel cage and slip ring induction motors, in which the circle diagram, so essential to a clear comprehension and calculation of the characteristics of induction motors, is explained and outlined. In another chapter he treats of the relative advantages of synchronous motors and induction motors and shows the proper respective spheres of these types. An example of induction generators and examples for practice in designing conclude the book. An appendix contains a valuable bibliography, which is unfortunately limited to the Transactions of the two great English-speaking electrical institutions.

It is a rare exception to find men, with the experience necessary for the writing of such a treatise, and with the ability to present their subject clearly, who are willing to undertake the wearisome task of writing such a book and seeing it through the press. This book is a compliment, not only to Mr. Hobart's engineering ability, but also to his character and his ideals, as few men possessing his experience would be willing to take the pains to write such a work. In the hands of the student, the electrical engineer, the designer, the consulting engineer, and the operator, the book will prove helpful and suggestive, and it will give those who are merely in superficial touch with the electrical profession an idea of fundamental principles and experimental data, which could not easily be obtained elsewhere.

In 1895 Prof. André Blondel published a little pamphlet on synchronous motors, which contained in a condensed form his theoretical investigations in connection with the parallel operation of alternating-current generators and synchronous motors, originally published in the volumes of "Lumiere électrique in 1892 under the title, "Sur le couplage des alternateurs." These papers in "Lumiere électrique" formed one of the greatest contributions to the theory of alternating-current phenomena and, while only imperfectly known, they contained the solution of all the fundamental problems in relation to parallel operation. "Lumiere électrique" was discontinued on account of commercial difficulties and these important papers, already difficult of access, had thus become buried in the tomes of a defunct journal. When Prof. Blondel republished part of these papers, in a condensed and simplified manner, in a little book on synchronous motors, his lucid presentation of this complicated subject was heartily welcomed by the student. However, the wider membership of the American electrical engineering fraternity never learned of the existence of this book, and they obtained their knowledge of the theory of synchronous motors from other works whose authors had been chary of giving to André Blondel the credit which so amply belonged to him. C. O. Mailloux, who has translated for us the works of other French authors, has again obtained our gratitude by presenting to us Blondel's little treatise in English form, and he has added to the value of the book by having Prof. Comfort A. Adams write additional chapters on rotary converters, supplementing Prof. Blondel's papers on that subject. Prof. Blondel's treatment of the stability of operation of rotary converters is one of the most interesting chapters of the book. The chapter on voltage ratio in synchronous converters with special reference to the split-pole converter, written by Prof. Comfort A. Adams, is another valuable adition to the book. The concluding part of the book deals with the calculation of armature reaction, and is taken substantially from a paper by Prof. Blondel before the International Congress at St. Louis in 1904.

Mr. Mailloux's translation of Prof. Blondel's book represents more than a mere addition to English electrical engineering literature. It is an entering wedge to show the American student and engineer of this country that almost all the fundamental scientific work which forms the foundation of the theory of alternating-current generators and motors is the work of great European scholars and that, of this work, a large moiety was done by Prof. Blondel before the opening of this century. Thus Mr. Mailloux has rendered a real service to all those who are interested in the true origin of the theories which they employ in their engineering and commercial labors.

An Elementary Book on Gas Power

GAS POWER—By C. F. Hirshfeld, M. Am. Soc. M. E., Professor of Power Engineering, and T. C. Ulbricht, M. Am. Soc. M. E., Instructor, Department of Power Engineering, Sibley College, Cornell University. [Being part of the "Wiley Technical Series," edited by J. M. Jameson]. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. x+209; 60 text illustrations. $1.25, net.

The preface of this little book states that the treatment has been made as simple and non-mathematical as possible to adapt it to the needs of students in the higher classes of manual training schools and other institutions devoted to industrial education. The authors think the book should also be useful to those who wish to obtain information in this field, but who have not had the advantages of a broad technical education.

There is no more difficult sort of technical writing, we believe, than that which is required to fulfill the conditions above set forth. In writing the ordinary treatise on an engineering subject, the author can assume that his readers are at least reasonably familiar with chemistry and physics and elementary mathematics; but when the task is to make a subject clear to a reader who has not this elementary knowledge, or who may have it only in part, the task becomes vastly more difficult.

It is, in fact, a common failing of all writers of technical literature to forget for the moment that the reader has not the knowledge which they themselves possess. The key to clear writing for any author, anywhere, at every page and every paragraph, is for the author to put himself in the reader's place and attempt to make the meaning so clear that the reader cannot fail to comprehend what is meant.

It is, we are aware, a difficult matter to judge just what should be put in and what should be left out of a book designed for the needs of such students as those described in the preface. It would seem to us, however, that a smaller amount of space devoted to theory and greater space to the problems of practical operation would make the book more useful.

The authors throughout the book refer to the Diesel engine cycle as if it were essentially different from the cycle of the ordinary gas or oil engine. While this is true of the

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theory originally promulgated by Dr. Diesel, the Diesel engine as actually built today cannot be said to differ in its cycle of operation from the ordinary oil engine in which the oil is delivered at the end of the compression stroke. In fact, except for explanation of the difference between the four-stroke cycle and the two-stroke cycle, we believe it is much the simpler way, in an elementary work at least, to consider all internal combustion engines of the present day as operating in the same manner and emphasizing the fact that all alike depend upon the combustion of fuel and air in an inclosed space and the expansion of the resulting gases against a piston.

We would not be understood as being unduly critical of the book before us, for as we have said, the task of presenting an elementary statement of all the main facts regarding the operation of internal combustion engines in such limits of space as this book makes available is one of extreme difficulty. We have no doubt that in many schools it will be found useful.

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Heating and Ventilation

Reviewed by REGINALD PELHAM BOLTON*

THE ELEMENTS OF HEATING AND VENTILATION—A Textbook for Students, Engineers and Architects. By Arthur M. Greene, Jr., Professor of Mechanical Engineering, Russell Sage Foundation, Rensselaer Polytechnic Institute; Some time Junior Dean, School of Engineering, University of Missouri. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. vi + 324; 223 text illustrations. $2.50.

Although not fulfilling all the hopes as to comprehensiveness held out by the Preface, this volume concisely presents the main considerations entering into the computation and proportioning of heating and ventilating apparatus, the subject matter being arranged in a more logical and consecutive order than in the majority of works devoted to these subjects.

The matter is also presented in a commendably simple form, the makeup of the book and its outline illustrations being clear and understandable, though the illustrations of furnaces bear the earmarks of trade publications.

Little material is devoted to some of those considerations which at the present time are of great concern and interest to heating engineers and information upon which is being sought eagerly by all students of the art. Thus, the important subject of district heating receives scant attention, much less than in Prof. Hoffman's "Handbook for Heating and Ventilating Engineers" and the question of humidity in conditioning air for ventilating purposes is not completely presented. The thorough student of this subject is sure to demand some information on the physiological side of ventilation and heating, but no light is thrown on this side of the subject.

The subject of boiler ratings and capacities could have been greatly benefited by the presentation of some of the facts brought out by the work, of Prof. Busey, in place of the restatement of manufacturers' ratings.

It is perhaps not to be expected that the large matter which is now agitating the profession, as to the fundamental requirements of ventilation, should be analyzed in a work intended for the student of the art, since the subject is one which at present is in the controversial stage. Still, it would be well that all students should receive some indication of the strong probability of a change of standards and accepted data, upon which the proportions and even the methods of ventilation may in future be based. As to this matter, the author says:

> The presence of 11 parts of CO_2 per 10,000 in air when the increase has been due to respiration is found to be oppressive and harmful. In cases of gatherings of healthy persons, this may reach 15 parts while with sick it should be kept as low as 7 parts . . . . When the CO_2 content is about 7 parts to 10,000, there is no evidence of discomfort and this may be taken as the limit for proper ventilation.

The student gains nothing positive from these figures and no indication that, in view of the negative results of recent experiments, it must apparently be conceded that the carbon dioxide content is no longer the determinate basis of the character of ventilation as it has hitherto been regarded.

In designing apparatus for practical purposes, the student's mind might be directed with advantage to the work effected by heating and ventilating appliances under operating conditions, and the variations of practical use, on which little has hitherto been written, and none of it in such form as to reach the student.

In the statement of the methods for proportioning heating apparatus, the losses by exposures and intermittent heating are re-stated in the empirical form of additions by 10 to 50% for various fixed conditions, such as appear in so many prior publications, instead of applying the determinate elements of wind effect and the results of recent experiments in the infiltration of air.

The subject of steam heating would gain by having more attention given to the question of vent-lines and the effects producible by the location of air valves in various positions.

It is perhaps too much to expect that every branch of a subject of so wide and complex a character as the design of heating and ventilating systems can be comprehensively presented within the covers of a single volume, but it is unfortunate if the limited space available is utilized for mere trade publication matter, which is the case with some parts of the subjects herein presented. Accompanied by an analytical discussion, such matter may become instructive, but this is lacking in such descriptions as those devoted to the ozonating apparatus and hot-air furnaces. These detract from the average quality of the contents, which nevertheless, shows a high percentage of intelligent presentation.

With these exceptions, the work of Prof. Greene may be considered a compact re-statement of the principles of the art of heating and ventilation. Special commendation is to be applied to the treatment of the subject of radiating surface and also to the methods of computation for indirect heating.

The systematic method offered of recording the facts and figures for the heating requirements of buildings can be commended as a substitute for the haphazard memoranda frequently used by engineers.

The variety of circumstances which now surround the subject of heating make the presentation of the whole of the elements entering into the art almost impracticable within the space of a single volume. The presentation of many of its main elements in so clear and well arranged a form as in this volume by Prof. Greene is a useful addition to the literature of heating and ventilation.

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PRACTICAL MATHEMATICS, Being the Essentials of Arithmetic, Geometry, Algebra and Trigonometry. Part III, Algebra with Applications—By Claude Irwin Palmer, Assistant Professor of Mathematics, Armour Institute of Technology. New York and London: McGraw-Hill Book Co. Cloth; 4½x7¼ in.; pp. xi + 178; 31 text figures. 75c., net.

Success in mastering the study of algebra must be preceded by a thorough understanding of the axioms and of the four simple operations, for all the more complicated processes are merely special variations and combinations of these. The author has evidently had this fact in mind in the preparation of this book, for particular attention has been paid by him to giving a clear and thorough treatment of these fundamentals.

Algebra does not lend itself naturally to graphical explanations in the same way as geometry, but in spite of this fact a number of illustrations have been introduced as an aid to the text. Also, as in the previous books on arithmetic and geometry (see these pages for Dec. 12, 1912), the attempt has been made to improve on the older methods of dry, impersonal instruction by illustrating the various principles with practical examples along the line of every-day application in shop and office.

Among other attractive features is an explanation of the operation of the slide-rule, rank heresy in a textbook on mathematics, according to the old standards of teaching. Another feature that stands out in the book is the portion which treats of graphics and their various applications in engineering work, such, for instance, as the study of indicator cards. In short, the book may be said to embody an attempt to instruct, interest and help the prospective student rather than merely to give him some abstract "mental training."

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THE LAWRENCE SURVEY—Report of Studies in Relation to Lawrence, made in 1911 by Robert E. Todd and Frank B. Sanborn, under the Advice of Francis H. McLean, Lawrence, Mass.: Trustees of the White Fund. Cloth; 6x9-in.; pp. 263; illustrated.

Housing, the water, milk and ice-cream supplies, sewage and garbage disposal and the general work of the local board of health were the main subjects included in the Lawrence Survey, as reported in this volume. It is expected that further investigations will be made later on.

The report on housing shows woeful neglect on the part of the city and, in the opinion of the investigator, great need for effective state legislation and supervision of housing in Massachusetts cities. Notwithstanding the large area included within the city limits, there is great congestion of population in Lawrence, and worse still the congestion is largely within four-story wooden tenement houses. A feature which partly relieves the situation is the thoroughness

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with which water-supply and sewerage facilities have been provided, including water closets for nearly every family.

Aside from the housing investigation, the details of this survey were entrusted to an engineer, Frank B. Sanborn. The local milk supply was given a thorough investigation by Mr. Sanborn, who also made a careful analysis of the work of the local board of health. Recommendations for improving the milk supply and also for improving the general health administration of the city are given. The report also contains useful information on the water-supply and on sewerage and garbage-disposal service of the city. The work of the survey as a whole is highly commendable, and it is to be hoped that it will be continued in Lawrence—particularly as regards the economic conditions which affect housing. Similar surveys might well be made in many other cities in Massachusetts and in other states.

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Heat Power Engineering

Reviewed by LIONEL S. MARKS*

ELEMENTS OF HEAT-POWER ENGINEERING—By C. F. Hirshfield, M. M. E., Professor of Power Engineering, and Wm. N. Barnard, M. E., Professor of Steam Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xiii + 811; 480 text figures. $5 (21s.), net.

There is but one satisfactory standard by which to judge a textbook, namely, that which the author or authors have set for themselves. In many cases the author does not take the reader into his confidence as to his purposes, but leaves him to derive them from the contents of his book; in such cases the reviewer may fail to grasp the author's full intention and may make the mistake of regarding as errors of omission or of commission, any departures from a complete fulfillment of his conception of the author's purpose.

In the preface to the book under review, the authors make their intention abundantly clear. They have attempted to include in a single volume not only the elementary thermodynamic theory of gases and vapors and of their cycles, but also the consideration of the sources of heat, the methods of making it available for useful purposes, its utilization in the various types of heat-driven prime movers and their auxiliary apparatus, together with a discussion of the fundamental theory, the ideal and actual performance and the practical considerations connected with such apparatus. The book, moreover, is stated to be prepared primarly for the use of students in Mechanical Engineering in their junior and senior years, after they have completed college courses in physics, chemistry, analytical and applied mechanics, and empirical machine design. The text is supposed to be supplemented by lectures, lantern slides, a study of trade catalogs and collateral reading, but as it is prepared primarily for students who will take separate courses in mechanical laboratory practice and in the economic problems connected with heat-power engineering, little attention is paid to these subjects.

A list of the subjects covered in the 42 chapters of the book will further show the scope of the work. They are as follows: heat; elementary laws of heat energy; the heat-power plant; the laws of gases; expansions and compressions of gases; reversibility; entropy; gas cycles; vapors; properties of steam; volume changes of vapors; vapor cycles; power, efficiency and performance; the theoretical steam engine; action of steam in real engines; methods of decreasing cylinder condensation; steam engines; steam engine governors; the valve gears of steam engines; conventional indicator diagrams; performance of steam engines; steam turbines; external combustion gas engines; methods of operation of internal combustion engines; their mechanical features; their efficiency, performance and power; fuels; combustion; furnaces, stokers and oil burners; boilers; superheaters; draft and draft apparatus; gas producers and producer gas; utilization of waste heat; heat transfer; feed-water heating; condensers and their auxiliaries; water purification; power plants; flow of gases and vapors through orifices and nozzles; compressed air; and refrigeration.

This is a formidable list of topics, but it should be possible to handle them all with some thoroughness in the 748 pages devoted to their exposition. An examination of the book discloses considerable irregularity in the degree of thoroughness with which the various subjects are handled. Much of the treatment is informational rather than analytical. Of the analytical portions, some are treated very superficially, while others, notably the chapter on heat transfer, seem to be aimed at students with much more preparation than is suggested by the rest of the book.

The reviewer finds it difficult to place the use of this book for junior and senior students of Mechanical Engineering. It seems an excellent book for the "general culture" student or for the student of civil or electrical engineering who is seeking general information on heat-power engineering, with some general knowledge of the elementary theory. It might serve also as an introductory course in what one of the colleagues of the authors has termed a concentric scheme of study. But junior and senior students should have passed already the outermost ring of a concentric course of study of one of their main subjects. Moreover, the detail in which many of the topics are considered is too much for a general introduction, but not sufficient for a thorough study. This is true, for example, of the treatment of thermodynamics or of valve gears. The book seems to fail of maximum utility by endeavoring to cover two fields, that of general information and that of detailed study of heat engines.

Accepting the book as it is, the reviewer finds it uniformly accurate. The expositions are notably painstaking and exhaustive and should make the subject clear to any student. The authors have followed the very desirable procedure of using the main part of the book in pamphlet or book form as a text for the past four years with their classes, and consequently the published book appears to be without any of the typographical and other errors which always creep into a new book.

It is to be regretted that the authors have not been satisfied to accept the current terminology in a number of instances. For example, the word "isovolumic" is a barbarism without any justification. "Progressive specific heat" is a particularly unfortunate name for the actual or instantaneous specific heat of a substance at any temperature. "Associated heat energy" is another unfortunate term, particularly as the context suggests at one time internal or intrinsic energy of a body (p. 9), and at other times the heat supplied to a body (p. 45). Then again, there does not seem any good reason for calling what is commonly known as a "hot-air engine" by the new name of an "external combustion gas engine." These are but minor defects, but with the rapid growth of new ideas and new inventions requiring a rapidly increasing scientific and technical terminology, there does not seem to be any justification for changing the accepted terminology unless the terms are misleading or otherwise unsatisfactory.

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A Defense of the New York Stock Exchange

THE STOCK EXCHANGE FROM WITHIN—By W. C. Van Antwerp. Garden City and New York: Doubleday, Page & Co. Cloth; 5x8 in.; pp. 457. $1.50, net.

In view of the numerous attacks upon the Stock Exchange and the current proposals to regulate its operations by law, this book is timely. It is written in an entertaining style and a large part of it is devoted to the recording of reminiscences and incidents which have little relation to the serious discussion of economic problems.

Something of the scope of the book may be gained from the titles of some of the chapters as follows: I, The Functions of the Stock Exchange; II, The Uses and Abuses of Speculation; III, The Bear and Short Selling; VI, Panics and the Crisis of 1907; VII, A Brief History of Legislative Attempts to Restrain or Suppress Speculation; X, The Paris Bourse, A Monopoly of the Government. An appendix contains the report of the Commission appointed by Governor Hughes, which made an investigation of stock-exchange methods.

The author is a stock broker and, as would naturally be expected, his book is a defense of the Stock Exchange as a legitimate part of the nation's business and of legitimate speculation in securities and commodities as a valuable means of steadying prices.

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THE NEW COMPETITION—An Examination of the Conditions Underlying the Radical Change That Is Taking Place in the Commercial and Industrial World—The Change from a Competitive to a Coöperative Basis. By Arthur Jerome Eddy, author of "The Law of Combinations." New York: D. Appleton & Co. Cloth; 5½x8½ in.; pp. 374. $2 net. $2.14, postpaid.

The spirit of this book could hardly be better stated, in brief, than in the following quotation from the chapter on "Harmony:"

Coöperation stands midway between the rank selfishness of individualism and the ultra-altruism of socialism; it offers a practical middle ground between the two extremes; rightly developed, it will suppress the evils of the one and yield the benefits promised by the other. In a sense it is the only refuge against Socialism.

The author discusses in clear, simple and impartial terms the economic and ethical changes that are taking place in the present transition period between the old competitive standards in business and industry, and the new spirit of cooperation which is daily growing in strength. Throughout

the book emphasis is placed on the advantages of complete publicity in every form of business and industrial relations.

The arrangement of the topics is logical and natural. Starting with an explanation of the old competitive system, its various laws and phases, and the conditions which fostered its growth, the author takes up the question of present changed economic conditions which lead to abuses under this system and explains how these abuses are to be remedied by publicity and coöperation. The subjects of relations between buyers and sellers and the relations of both to the general public, fair prices, trusts, labor problems, class and constructive legislation are treated at some length. Interesting matter is given on the subject of different forms of combinations of industrial and labor forces.

Where does the interest of engineers lie in a book of this nature? There is hardly a field of human activity where engineers and engineering methods have not been introduced to advantage. But too often the engineer has been the tool for these changes rather than the director. It has been the exceptional engineer who has been able to take a place with the statesman and financier in shaping public opinion and public policies. Engineers like to claim that it is their innate modesty which has held them in the background. However that may be, it is to be hoped that in the future the engineer will sufficiently overcome this "modesty" to enable him to take his rightful place in political and commercial life. Before most engineers can do this they must gain a wider horizon. A book of this kind may be made one means to that end.

Hoisting from Deep Mines

Reviewed by E. T. SEDERHOLM*

WINDING ENGINES AND WINDING APPLIANCES—Their Design and Economical Working. By George McCulloch, Inspector of Machinery, Department of Mines, West Australia, and T. Campbell Futers, M. Inst. M. E., author of "The Mechanical Engineering of Collieries." New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 6x9 in.; pp. viii + 452; 175 illustrations. $6. net.

The authors of this book have filled a want felt for many years by all engineers who have had to deal with the problem of hoisting from deep mines. Their work deals entirely with mine hoists, more especially hoists for deep mines, but it is in this field that the available information has been so scanty. Much of the book is devoted to descriptions of types not used in this country, and which probably would not be desired here, yet the work deals in such an admirable manner with the whole theory of hoisting, and brings out so much that is little known in practice, that besides its usefulness as a work of reference, it is well worth reading from beginning to end.

The introductory chapter is one of the most important, dealing as it does with the manner of attacking any new problem of hoisting that may present itself. There are few fields in engineering where there are more different considerations that need to be reckoned with than in hoisting, and the writers show very clearly how the calculations should be made in an orderly manner. An American engineer might take exception to some of the coefficients used, like that of 25% for engine friction, but this detracts but little from the value of the discussion since the principles explained after all are the main thing.

The chapters on styles and types of hoisting engines are of great interest, and describe different drums as well as engines. Then follows a large amount of information regarding tests made to determine the economy of hoists in actual work, a subject that heretofore has been dealt with only in isolated reports and in articles in technical papers. The authors compare the different types and weigh their respective advantages and disadvantages. In subsequent chapters the difference in requirements for hoists intended for ore and those for coal is set forth. The coal hoists especially are almost entirely according to British practice, and they differ quite a little from those used in this country.

Electric hoists are fully described, at least those of the larger kind. Many appliances are described that are but little known outside of the somewhat limited circle of men connected directly with this branch of the work. A comparison, though rather partial, is made between steam and electric hoists, but it loses considerably in value from the fact that while in the case of the steam hoists the economy is based on actual performance, for the electric hoists reliance has been placed mostly on mere assumptions.

The chapters on engine details contain little of American practice, but drums, brakes and clutches show more that is familiar even though some of the forms have been changed from the originals without being improved—as, for instance, the band clutch that has had its band cut in two, thereby losing one of the chief advantages of this form of clutch, that of great friction with little exertion of power for operation. One looks in vain for any form of clamping clutch, such as are so successfully used here on the best types of large hoists. In the same way parallel operated post brakes are not even mentioned. In contrast, there is a fund of information regarding safety devices, especially automatic stops to prevent overwinding, a subject that has heretofore received but scant attention.

In dealing with hoisting ropes the writers have used as a basis the excellent work on this subject by Prof. Hrabak. It is unfortunate, however, that the writers should have allowed themselves to be misled by the fact that the first part of the professor's book contains information which he in the latter part retracts, because he then found that it applied only to new ropes, and that the bending strains in ropes that had been in use even only a little while were much more severe. Many readers of this work on "Winding Engines" are apt to be misled in turn thereby, which is so much more unfortunate since the subject of strains in hoisting ropes is but little understood anyway.

In the last chapters, cages, skips, landing devices and headgears are described in detail. Much of this is foreign to American practice, yet much is also of considerable value to us. And, as throughout the volume, even that which cannot be made directly useful here, is at any rate extremely interesting. In fact, there is very little in the work which does not deserve careful attention or would fail to interest any engineer that has anything to do with the hoisting problem.

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Radioactivity

Reviewed By CHARLES BASKERVILLE*

PRACTICAL MEASUREMENTS IN RADIOACTIVITY — By W. Makower, Lecturer and Demonstrator in Physics, and H. Geiger, Lecturer in Physics, University of Manchester, England. New York and London: Longmans, Green & Co. Cloth; 5x9 in.; pp. ix + 151; 61 text illustrations. $1.60, net.

The authors say: "Although researches into the nature of radioactivity have proved one of the most fruitful means of investigating atomic phenomena, a study of the methods employed for making radioactive measurements has not come to be regarded as an essential part of a course of practical physics, or chemistry." These researches are usually mentally associated with elaborate (hence expensive) apparatus. This book shows this idea not to be true and gives very specific directions for laboratory work on the part of students; yet furthermore it is of help to investigators as well. Experiments designed by Rutherford for careful measurements, methods for isolating radioactive products worked out by Boltwood, theories of instruments—for example, the quadrant electrometer, as given by Beattie—are incorporated. The theory of each experiment is usually given. The book is a splendid contribution to pedagogic literature, a laboratory manual par excellence.

PANAMA, PAST AND PRESENT—By Farnham Bishop. New York: The Century Co. Cloth; 5x8 in.; pp. xvi + 271; 90 illustrations; 75c., net.

Of the sixteen chapters which the book contains only one is devoted to the work being done on canal construction under the Americans. A chapter which follows, however, is entitled "How We Live On the Isthmus Today" and the next chapter is entitled "How Colonel Goethals Has Made Good." The remainder of the book is essentially a history of Panama. The author has succeeded in making this history as entertaining as a novel, in fact considerably more entertaining than the average novel of the present day.

The author of the book is a son of Mr. Joseph Bucklin Bishop, who has been the secretary of the Isthmian Canal Commission practically since its organization. The author modestly says in his preface that he hopes his book will appeal to the average boy; but he has told his story in such an interesting way that we believe his book will appeal quite as much to mature readers. Many of the facts related in this little history are common talk among the engineers employed on the canal; but the author has unearthed many others from his searches in libraries and official records. Such chapters as that on the Panama railroad contain many bits of forgotten engineering history which were well worth

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the finding and recording. The book is just the sort of present-day literature that should be on the shelves of every public library.

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The Mathematics of Electricity

Reviewed by H. H. NORRIS*

THE MATHEMATICS OF APPLIED ELECTRICITY—A Practical Mathematics. By Ernest H. Koch, Jr., Instructor in Mathematics, School of Science and Technology, Pratt Institute, Brooklyn, N. Y. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xvi+651; 316 text illustrations. $3 (12/6), net.

There is a growing interest in promoting the use of mathematics in engineering work. Teachers of mathematics are attempting to bring the subject down out of the clouds so that the everyday man may have the benefit of it as a tool. At the same time the disciplinary value of the subject is being kept in mind, for all agree that the mental processes necessary in the solution of problems by mathematical means are the same as those required in all analysis of however practical a nature. Under these circumstances every contribution in the field of the mathematical instruction of engineering students is welcome.

Mr. Koch's book is an attempt to correlate mathematical principles with their application to electrical and allied problems. Like many other textbooks, it has been "tried out" on the author's students, in this case at the Pratt Institute in Brooklyn. In his judgment "the book has demonstrated its usefulness as a powerful and interesting presentation which has promoted the student's fidelity, poise, common sense and tact in his applied work and in subsequent success in foremanship, superintendence and in other executive and administrative positions." How Mr. Koch has developed his course to accomplish these results is outlined below.

The general plan involves a division into three parts: (1) The transformation and interpretation of formulas, and direct-current problems, (2) the graphs of formulas and the formulation of graphs, and (3) vectors and vector diagrams and alternating-current problems. There is a mass of information on these subjects, the whole being a curious assemblage of lower and higher mathematics, mechanics, physics of electric circuits and apparatus, construction and theory of electrical machinery, electrical measuring instruments and measurements.

The first quarter of the book is taken up with a review of elementary arithmetic, algebra, trigonometry and geometry, evidently intended as a basis for a rapid and practical review of the fundamentals. This part is non-electrical. Then follow nine chapters dealing largely with electric and magnetic circuits. These chapters are virtually collections of problems which can be solved by means of the fundamental operations previously illustrated. Part I ends with chapters on mensuration, quadratics and problems on the strength of materials. Part II contains chapters on mathematical subjects, particularly showing the nature of graphs and operations upon them. The topics covered are: The use of squared paper, linear graphs, non-linear algebraic equations, eccentricity of conics, the formulation of graphs, the use of polar paper, solving formulas by charts, measurement of angles, harmonic motion, rates, derivatives, integrals and experimental curves. This section makes little use of electrical illustrations. It ends with a chapter on electrical measurements and measuring instruments. Part III, which treats of alternating-current problems, consists almost entirely of illustrative electrical problems and is more of a treatise on electricity than mathematics.

Mr. Koch's book illustrates what is almost sure to result when the teacher of mathematics attempts to apply his mathematics to engineering problems in the class-room. That is, he teaches more physics than he does mathematics. In this book, of somewhat more than 600 pages, the whole field of electrical engineering is covered. Some of the electrical problems are of most advanced character. It is true that problems must be made interesting to have them appreciated, but it is doubtful if mathematics can be taught as an adjunct to physics and engineering. In this case many of the problems which appear near the end of the book and which, therefore, would be assumed to be advanced from the mathematical standpoint, involve practically no mathematics. They do, however, require for their solution a knowledge of the construction of electrical apparatus and of its characteristics. It seems to the reviewer preferable to treat mathematics, electrical physics and electrical engineering in separate courses and in the order given. Illustrations drawn forward into a course in mathematics tend to confuse the main purpose of the instruction. Mathematics can be made tangible and interesting without loading it with advanced electrical theory, the physics of which is far more difficult for the student to understand than is the mathematics. If this point of view is the correct one, Mr. Koch's book, which gives evidence of careful preparation and which is copiously illustrated with problems and diagrams, should be more useful to the advanced student and the engineer for reference and review than to the student of elementary mathematics. It is to be commended for the consistent attempt to make every statement tangible and concrete. The author's italicized "observations," which are inserted at frequent intervals, state fundamental principles in concise language.

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How To Build a Railroad

Reviewed by H. R. PRATT*

RAILROAD CONSTRUCTION—By Charles Lee Crandall, M Am. Soc. C. E., Professor of Railroad Engineering, and Fred Asa Barnes, M. Am. Soc. C. E., Assistant Professor of Railroad Engineering, Cornell University. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 321; 79 illustrations. $3, net.

Railroad construction has made vast strides in the last few years, and heavy and complex work is being accomplished in a skillful and permanent manner, under efficient engineering direction and supervision, by contractors with competent field organizations, handling a plant that is designed and so distributed as to obtain its maximum working capacity. On railroad construction of magnitude, embracing large quantities of concrete masonry, deep cuts, high fills and extensive and complicated tunnel building, the largest percentage of the work is done by machinery and transportation equipment, and the character of construction that formerly required years to complete is now reckoned in months.

The book before us touches practically all the principal steps in the construction of a railroad from the location of the line to laying the track and completing the railroad ready for operation, and gives a good general idea of the details required in properly executing such an undertaking.† It brings down to date facts about building railroads that are very useful, not only to the young engineer, but also to those who have constructed miles of railroad. It treats in a plain and practical manner the essentials of railroad construction and gives examples of standards that are the product of years of experience on various railroads.

In dealing with unit contract price for grading, however, the authors seem to lean toward classification of materials, while in work of any magnitude there is a rapidly growing tendency toward unit prices without classification, and with keen competition among contractors a reasonable unit price is obtained, the work expedited and controversies avoided.

As a whole "Railroad Construction" is a useful book for any engineering library or technical school, as it treats of the actual and real work in railroad construction and is not filled out with fine-spun theories that are useless to engineers of action who accomplish lasting results in railroad construction.

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An interesting bulletin on "Sand Available for Filling Mine Workings in the Northern Anthracite Basin of Pennsylvania" has been issued by the Bureau of Mines (Washington, D. C.). The report does not describe engineering methods, but is devoted chiefly to available sand deposits for use for the purpose stated. It may be explained that the object of filling coal-mine workings with sand or waste materials by some hydraulic means is to make it possible to reduce the volume of coal left for pillars. The following paragraph from the prefatory note is of sufficient interest to be worth quoting:

This small bulletin by Mr. Darton is not intended as a contribution to the engineering features of the methods of flushing. What Mr. Darton was requested to do, and endeavored to do, was to bring together in as short a space as practicable the results of his own observations and the observations of others concerning the general character and distribution of the unconsolidated materials available for filling the mine workings in the northern anthracite field of Pennsylvania. It is hoped that this volume may be of some service to the engineers who are endeavoring to work out in detail the problems that must be solved before it will be possible to determine definitely the extent to which it may be practicable, under the economic conditions existing at the present time, to use the flushing system in filling the mine workings of the anthracite region.

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†After a general introduction a chapter is given to each of the following subjects: Earthwork, Rock Excavation, Tunneling, Masonry, Foundations, Culvert and Bridge Masonry, Trestles and Bridges, Track Material and Roadbed, and Estimates and Records.

An Exhaustive Book on Worm Gearing

Reviewed By JOHN J. FLATHER*

WORM GEARING—By Hugh Kerr Thomas, A. M. Inst. M. E. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. ix+86; 33 illustrations. $1.50, net.

Notwithstanding the fact that worm gearing and spiral gears have come into extensive use of late years with certain classes of machinery, the opinion is still prevalent that worm gearing is necessarily short lived and inefficient. Much has been written in the technical periodicals concerning this little understood subject, but the material is not generally available to the designer. The subject has also been treated in the various books on machine design, but as might be expected in any treatise which covers the whole field of machine design the presentation of any portion, such as worm gearing, must of necessity be brief. Halsey's little book on "Worm and Spiral Gearing," published ten years ago, has been used by designers with a good deal of satisfaction but the present work is believed to be the first of its kind to deal exhaustively with worm gearing.

Primarily the subject has been treated in its application to automobiles, in which use the author has had a wide experience. However, the principles of design based on complete analyses of the problem are applicable to any case where worm gearing may be employed.

As the author points out, "since the early days of experiments so much actual experience in daily use with worm gears of all sizes has been possible that it can now be said that something approaching finality has been reached, and the art of making worm gearing has been placed upon a substantial foundation."

It is probable that the method of construction of worm gears has as much, if not more, to do with the high efficiency obtained than the application of exact theory. In this respect the discussion of choice of materials and method of manufacture constitutes a valuable part of the book. Efficiencies of 99.5% and over are only obtained by the employment of extra rigid machinery and the exercise of the greatest care; but where such precautions are taken the above efficiencies will result under favorable circumstances, provided the mounting be equally rigid.

In discussing the efficiency of worm gears the author shows that for the usual lead angles the efficiency may be obtained with sufficient accuracy for all practical purposes from $\eta = \frac{1 - \mu}{1}$ where μ is the coefficient of friction. For automobile gears running in an oil bath μ is assumed at 0.002, from which an efficiency of 99.8% is obtained. This high value appears to be corroborated by various tests. In these cases it is assumed that the sliding friction of worm gear is substantially the same as the sliding friction of a journal in its bearing; and further, that the tooth pressure and velocity are such as will permit the inclusion of a film of oil between the sliding surfaces.

It seems rather illogical to deduce an expression for the included angle of worm thread based on the angle of lead, as shown in Chapter V, pp. 22-26, and then adopt a uniform angle of 60° for all gears; this does not agree with the deductions determined on the theory of reversibility; however, in explaining this divergence the author states that the practical advantages of a uniform included angle are numerous, and that the perfection of workmanship obtained in modern worm gears affects neither the reversibility nor the efficiency.

There appears to be a slight confusion in the use of the symbols for tooth pressures in which the torque is used as a force in pounds instead of as a moment in inch-pounds. Other minor inaccuracies of statement are noted but the intent is evident and no serious difficulty should be encountered in laying out a worm-gear drive in any case which might arise in practice.

This book will be received as a welcome addition by the machine designer for it carries with it the stamp of authoritative statement.

A MANUAL OF CEMENT TESTING—For the Use of Engineers and Chemists in Colleges and in the Field. By William Allyn Richards, B. S. in M. E., Instructor in University of Chicago; and Henry Briggs North, D. Sc., Associate Professor of Chemistry, Rutgers College. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. vii+137; 54 text illustrations. $1.50, net.

The requirements of cement testing are fully set forth in the Standard Specifications adopted by the American Society of Civil Engineers and the American Society for Testing Materials, but the technique of testing, that is, the precise methods and apparatus needed, varies somewhat with the different laboratories. The manual before us outlines standard methods and describes standard apparatus, the adoption of which has been shown to satisfy the specification requirements noted above.

The book describes briefly the nature of portland cement, takes up in sequence the methods of making the various standard tests, describes the necessary laboratory equipment and finishes with a section of 27 pages on the chemical analysis of cement.

Some British Municipal Engineers

THE CIVIC ENGINEER'S WHO'S WHO—Compiled by the Editor of "The Surveyor and Municipal and County Engineer." London: The St. Bride's Press. Paper; 4x6 in.; pp. 120. 2/6, net.

Commendable enterprise has been shown by the publishers of "The Surveyor and Municipal and County Engineer" in gathering and publishing a series of about 200 biographical sketches of the leading municipal engineers of England and Wales. Besides what we should here call city engineers, and a few engineering heads of water departments, the list includes a leading official chemist or two, and the secretaries of some of the principal engineering societies of Great Britain.

The editor states in the foreword: "Obviously it has been necessary to ask the subjects of most of the biographies to supply the facts incorporated, but for the comments in some cases added the editor is solely responsible." This plan has its advantages, but in reading some of the sketches one would like to know what part of the statements made came from the subjects of the sketches, and what from the editors.

It is charitable to suppose that such words as those quoted in the next paragraph were written by the editor, but one cannot help having a suspicion that the subject of the sketch had a hand in the neat little advertisement for a proprietary article, which appears in the opening sentence. We quote as follows:

Probably Mr. —— —— name will be longest preserved as the inventor of "Tarmac," a special form of tar-macadam, which has been widely adopted, with most satisfactory results, as an almost ideal form of impervious road construction. Not only is the material itself a boon to the road engineer, but its invention, and the special study Mr. —— —— has for long made of the science of road construction generally, have undoubtedly given to the better roads movement an impetus for good, the full benefit of which has not yet been seen. Personally, Mr. —— —— is immensely popular with all who know him. Neither the wear due to his almost reckless indulgence in work nor the toll exacted by occasional severe illness has impaired the natural cheeriness of his disposition. Many a young engineer can testify that he is ever a sane counsellor and a ready helper.

As a contrast to the foregoing advertisement and tribute to Mr. —— —— popularity and cheerful disposition, we quote from a sketch of Lieut.-Colonel Alfred Stowell Jones, for many years manager of the Aldershot Military Sewage Farms:

While serving as a Lieutenant in the 9th Lancers he passed the examinations of the Public Works Department, India, in 1857, for employment as a Civil Engineer, and graduated at the Staff College in 1860. He was present at the battle of Budleekeserai, and at Delhi throughout the siege operations, and served with the 9th Lancers in Greathed's pursuing column, being present in the actions of Bolundshuhur and Allyghur and the battle of Agra, where he was dangerously wounded, receiving a musket-shot wound and twenty-two sabre cuts. He was mentioned in the despatches of Sir Hope Grant on three different occasions (Brevet of Major, Victoria Cross, medal with clasp). He was awarded the Victoria Cross for a gallant action while serving with the 9th Lancers. "The cavalry charged the rebels and rode through them. Lieut. Jones, ... with his squadron, captured one of the guns, killing the drivers, and with Lieut.-Col. Yule's assistance turned the gun upon a village occupied by the rebels, who were quickly dislodged. This was a well-conceived act, gallantly executed."

As to the character of this "Who's Who," it may be stated further that the sketches are in narrative form, and range from two to three lines to as many pages in length. A good general idea is often given of the personal and professional history of the subject of the sketch, together with information regarding his society and club memberships and also his authorship of books and papers. The publishers may perhaps be excused, all things considered, for apparently having referred to any and every important article written by the subject of their sketches for publication in their own journal.

The plan of depending upon each author for the preparation of his sketch, and the apparent unwillingness of the publishers to bluepencil as freely as might be expected, leads to the inclusion of a considerable number of trivial incidents and to the recording of minor pieces of work. As examples we may note the following statements: "He revised the design for a 4,000,000-gallon [Imp.] brick-covered service reservoir, thereby reducing the estimated cost by £7000 [what could the original estimate have been?—Ed.], and reported

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on the designs of three more such reservoirs of 1,000,000 gallons capacity each." This same engineer, we are told, has checked (not merely once) "at different times the whole of the stresses in some steel railway bridges, including a swing bridge 146 ft. long, and three N1girder bridges 550 ft., 570 ft. and 360 ft. long, respectively"—and he lived to tell the tale. However, it is only fair to quote the explanation which follows: "The chief interest in these was the different methods of erecting them, which caused ties to act as struts and vice versa, besides other complications."

Doubtless some of these small items of professional work will be cut out of future editions. Most of the subjects of sketches have had too good a sense of proportion, and of humor as well, to go into such minutiæ.

The "Who's Who" as a whole is a creditable production, which we hope will be continued and at the same time extended to include many more names. A little systematizing would save enough space to make it possible to include many brief sketches. As a matter of utility, only a few lines are really needed in the case of a majority of the names which might properly be included in such a volume. The briefer sketches could be gradually expanded year by year, as opportunity or occasion arose.

DD. Eng. Lit. Set Jan. 24

Drawing and Descriptive Geometry

Reviewed by ROSSITER R. POTTER*

MECHANICAL DRAWING—A Treatise on Technical Drawing as Expressed through the Medium of the Graphic Language. By Otho M. Graves, Assistant Professor of Graphics, Lafayette College; author of "Orthographic Projection." Easton, Penn.: The Chemical Publishing Co. Cloth; 6x9 in.; pp. vi + 138; 98 text figures and 22 plates. $2.

DESCRIPTIVE GEOMETRY—By Adam V. Millar, Assistant Professor of Drawing, and Edward S. Maclin, Instructor in Drawing, University of Wisconsin. New York and London: McGraw-Hill Book Co. Cloth; 5x8 in.; pp. vii + 131; 78 text figures. $1.50, net.

Mr. Graves has given to the world an orthodox elementary textbook on mechanical drawing, no worse and no better than a number of its predecessors. After the inevitable opening chapters on the use of instruments and on general instructions, comes one on lettering. This is followed by chapers on the construction of the conic sections, orthographic projection, working drawings, bolts and screw threads, and a final chapter on tracing cloth and blueprinting. A refreshing feature of the chapter on lettering is the generous acknowledgment given to the work of Charles W. Reinhardt as the originator of the system of lettering presented. Many authors who have drawn more heavily on Mr. Reinhardt's book on lettering have been less honorable. In the chapter on orthographic projection is a long list of problems consisting of orthographic drawings to be made by the student of objects represented in the text by dimensioned isometric drawings.

The conventional representations of screw threads given in the chapter on bolts and screws include the method in which the thread is represented by a series of light lines drawn completely across the projection of the screw alternating with a series of heavier lines drawn only half way across. The author, however, was apparently ignorant that this method can be made to add clearness to the drawing by serving as a form of shade lining, for the illustrations repeatedly show the short heavy lines drawn on the wrong side. Another error and one which reflects not only on the author, but the publisher as well, is the systematic misspelling of the word "frustum" both in illustrations and text.

The appendix outlines an elementary course in drawing and lettering and concludes with a set of instructions for 22 plates for such a course. These instructions are supplemented by illustrations consisting for the most part of sketches, partly completed drawings, etc., to assist the student in preparing the plates.

The excuse given by Messrs. Millar and Maclin for adding to the long list of textbooks on descriptive geometry already on the market is the endeavor "to make the subject easier for the student, to help the student visualize magnitudes in space and to present the subject more nearly in accord with commercial practice." These three things are accomplished, it is claimed, at one fell swoop by the omission of the ground line. It is pointed out that the relative distances from each other of the vertical projecvtions or the horizontal projections of a group of points, and not their distance from the ground line, is the thing to be emphasized. The ground line is, of course, understood in all cases to be at right angles to the line joining the horizontal and vertical projection of any given point, but it is not drawn in on the diagrams. This omission is expected to center the student's attention on the object in space instead of on the planes of projection. As a further step toward bringing the subject into accord with commercial practice, the authors use third-quadrant projections instead of first-quadrant.

There will be some difference of opinion in regard to the efficacy of omitting the ground line as a means for making the subject easier for the student and as an aid in developing his powers of visualization. The authors state, however, that this method has been used at the University of Wisconsin "for some time" and that the results have been most satisfactory. Apart from the omission of the ground line, the book is chiefly distinguished by its conciseness and by the generously long lists of problems given in connection with each chapter.

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A Remarkable Book on Steam Turbines

Reviewed by H. E. LONGWELL*

STEAM TURBINES: THEIR THEORY AND CONSTRUCTION By H. Wilda. Translated from the German by Chas. Salter, and revised and adapted to English practice. [Being Vol. V of the "Broadway Series of Engineering Handbooks."] New York: D. Van Nostrand Co. London. Scott, Greenwood & Son. Cloth; 4x7 in.; pp. ix + 191; 104 text illustrations. $1.25 (3/6), net.

One is inclined to suspect that this book, which is one of "The Broadway Series of Engineering Handbooks," was written to order in accordance with rigid specifications covering only the size and the price. The first two chapters (71 pages) are devoted to a theoretical consideration of the subject. The four remaining chapters are taken up with descriptive matter of the most superficial and inadequate character. The book has no preface. It gives no information regarding the author and the translator other than their names. Whether or not it was a reasonably sane work in the original German, it is impossible to conjecture. As done into English, it is nothing short of delirious.

As an index to the quality of the book, the following extracts—which are by no means exceptional—will suffice (black-faced type mine):

The theoretical work done in a turbine is determined by **the available loss of heat.**

The velocity of the steam at its outlet from a reaction turbine must be less than at its outlet from an impulse turbine, energy being given up continuously.

Since in reaction turbines the loss of heat in the exhaust steam is usually only about one-half of that in the impulse turbine—on the assumption of equal peripheral speeds—it follows that the reaction turbine must have about twice as many pressure stages as an equivalent impulse turbine.

Clearance Losses: In single impulse turbines (De Laval, Fig. 15), the steam which flows through the nozzle, but does not impinge upon the wheel, possesses no useful kinetic energy. A reduction of the wheel friction can be brought about by superheating the steam in the turbine casing, and by giving the laterally escaping steam a rotary movement in the direction of the rotor. The gain in power attained in this way is, however, immaterial in comparison with the clearance loss.

In turbines with a single pressure stage and several velocity stages, the clearance losses are always fairly large **on account of the increase of volume of steam flowing through.**

A characteristic feature [of the Zölly turbine] is the radial widening of the rotor vanes, this giving a delivery angle smaller than the entering angle. Owing to the outwardly increasing sectional area between the vanes of the rotors, the steam expands, and although there are no expansion nozzles, the Zölly turbine must be regarded as a multiple-stage impulse turbine without velocity staging.

All of this, and much more of a like nature, is hopeless gibberish, devoid of any gleam of intelligence.

On page 62 is the following:

The indicated steam consumption C1 may be set down for impulse turbines at

$$C_1 = \frac{2544.6}{H_0 - H_1} \text{ lb.} \qquad (46)$$

per theoretical or "indicated" horsepower-hour, and for reaction turbines as

$$C_1 = \frac{1{,}980{,}000}{778\,(H_0 - H_1) - \frac{U_2^2}{2g}} \qquad (47)$$

Equation 46 is correct for determining the steam consumption of an impulse turbine of 100% efficiency, but one wonders why it does not apply equally well to any other type of turbine of 100% efficiency.

Speaking of the use of turbines for driving centrifugal blowers, the author gives us the following interesting information:

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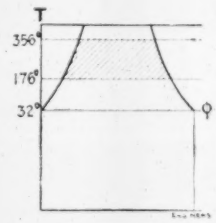
Thus a 10-in. blower driven by the first named [De Laval] turbine at a speed of 335 revolutions per second and a water gage pressure of 224 in. delivered 1 cu.ft. of air, 4 hp. being required for a working pressure of 145 lb. per sq.in.

As in the case of centrifugal pumps, it is possible by coupling several blowers together, to deliver air at a pressure of 90 lb. per sq.in., with an expenditure of 350 hp.

It is a pity that the limited size of the volume did not not allow the author to explain how the blower driven "at a water gage pressure of 224 in." succeeded in delivering 1 cu.ft. of air at a working pressure of 145 lb. per sq.in., and how long it required to accomplish this feat. The average reader would also be interested to know why there is no apparent limit to the quantity of air that may be delivered against a pressure of 90 lb. per sq.in., with an expenditure of 350 hp.

Naturally the author dallies a little with the temperature-entropy diagram, which in some instances he interprets in a way that is surpassingly grotesque. For example, on the conventional diagram for saturated steam (reproduced herewith) the hatched portion is said to represent "a product of temperature and entropy, **and, therefore, the amount of heat in B.t.u. which must be spent in converting saturated steam at 176° into saturated steam at 356°**" (black-face type mine).



The book throughout tells so plainly its own story of pitiful incompetency, that to offer it as a serious work on an important branch of engineering, is an imposition on the confidence of the public. If, however, anyone should be desirous of getting a real bargain in "piffle," the book can be recommended unhesitatingly, as containing the largest amount of this commodity that has ever been offered for the modest sum of one dollar and twenty-five cents.

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High-Tension Line Calculations

Reviewed by C. D. GRAY*

TRANSMISION LINE FORMULAS FOR ELECTRICAL ENGINEERS AND ENGINEERING STUDENTS. By Herbert Bristol Dwight, Assoc. Am. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. vi + 137; illustrated. $2, net.

The author of this book has appreciated the lack of a collection of easily applied formulas for the calculation of the electrical characteristics of high-tension lines, and has attempted to produce a collection that would be useful, not only to the practicing electrical engineer, but also for the use of students in the classroom. He has appreciated the fact, too often lost sight of, that the shorter and lower voltage lines do not need the same refined method of calculation as those of moderate length and voltage; while at the same time he has included the more complicated formulas for use on lines of greatest length and highest voltage. The author has inserted in the various chapters actual examples, so that the application of the formulas is easily learned, and one who uses them infrequently should not find any difficulty in securing correct results.

The author has also realized that in many cases it is necessary for an engineer to secure approximate results quickly with but little calculation, and so he has included a very good chart by means of which one can easily obtain results that are close enough for the purpose of making preliminary calculations and estimates on high-tension transmission lines, which method is explained in Chapter III.

In Chapter IV are given the formulas for short lines, in case one wishes more careful results than the chart would give. These formulas are easily understood, and are to be used for lines up to twenty miles in length. For longer lines, where the capacity of the line must be considered, the "K" formulas, Chapter V, are to be used, and sufficiently good results can be obtained for lines up to two hundred miles in length. As stated, these do not take into account the losses from corona or insulator leakage, which factors do not become serious until a voltage of 100,000 or over is used.

Chapter VI takes up the solution of the problem by means of the convergent series, in case a very careful calculation is desired, which will involve the leakage conductance of the line, including corona loss and insulator leakage. These are applicable for lines of any length and voltage and will give as great accuracy as is possible.

Part II gives the theory used in making up the formulas and tables and is useful to a good understanding of them. It takes up the usual topics of temperature effects, reactance capacity, skin effect, etc. Part III is a solution of the formulas condensed into working shape, tables of resistance, reactance, susceptance, etc., needed in using the various formulas.

In general, this book seems to supply a want long felt by busy engineers for a collection of easily understood and applied formulas for high-tension transmission-line calculation. It is unfortunate, however, that the author has not included a chapter on corona, with tables showing critical voltage for various-sized wires at different spacings and losses per mile of circuit, based on some formulas which are now being accepted by engineers as correct, as far as experiments to date show, such as Peek's Formulas, given in the Transactions of the American Institute of Electrical Engineers, June, 1911, and 1912.

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Tracing Old Survey Lines

BOUNDARIES AND LANDMARKS—A Practical Manual. By A. C. Mulford. New York: D. Van Nostrand Co. Cloth; 5¼x8¼ in.; pp. vii + 89; 19 text illustrations. $1, net.

We can give no better and clearer conception of this instructive and exceedingly interesting little book than the author himself has ingenuously written in the final chapter on the "Responsibilities of the Surveyor." Mr. Mulford writes:

This very brief treatise is not intended as a handbook for surveyors in any way; it is not didactic—it is suggestive only. It is intended to give a little light to men thrown, for perhaps the first time, on their own responsibility, or brought face to face with problems which they have not met in their previous experience. For the solution of these problems no general rules can be laid down; each man must work out his own salvation. All that I hope to do is to give a few suggestions from hard won personal knowledge which may make the road a little easier.

The problems of boundary lie at the foundation of all surveying, for one must know where a line is before he can measure it, and the solution of these problems calls for the same powers of accurate observation and of consecutive and logical thought that are demanded for successful work in any branch of modern science. It is needless to say that the successful surveyor must be accurate in his instrument work and in his computation; yet, if he would really succeed, he must go beyond this. He must add to this the patience to collect all the evidence which can be found bearing upon the case in hand, together with the ability to weigh this evidence to a nicety and to determine clearly the course pointed out by the balance of probability. The watchwords of the surveyor are Patience and Common Sense.

We doubt not that many a young technical graduate has been "stumped" as completely on some property or lot survey as on any other problem he has ever encountered, at least in the East, where the original property lines are very old and notoriously indefinite. All the college textbooks on surveying in the world are not worth a fraction of the advice and counsel of an experienced land surveyor. What are landmarks and how are we to recognize them if we see them; how are the landmarks to be used provided we think they are recognized? These are questions upon which the book before us throws many a ray of light, which can come only from one who has gleaned much from personal experience.

The subdivision of property into house lots, how it is commonly done and the problems arising therefrom, are too well known to every experienced surveyor to need emphasis; in such cases the theory and practice of surveying are secondary to other considerations when it comes to straightening out and adjusting the problems of irate lot owners. As the author states, "there are no fixed rules which can be laid down for the accurate handling of old lot layouts. Satisfactory results can be obtained only through care, patience and common sense and, above all, honesty."

The book is free from all mathematical formulas, it does not pretend to instruct in the theory of surveying; but it would from a most valuable appendix to any textbook on surveying. To the young and inexperienced land surveyor it will prove an unfailing source of consolation and instruction.

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MINING ENGINEERS' EXAMINATION AND REPORT BOOK—By Charles Janin, Consulting Mining Engineer. San Francisco, Calif.: Mining & Scientific Press. London: The "Mining Magazine." Part I, Flexible leather; 5x8 in.; pp. 94; illustrated. Part II, cardboard; 8x5 in.; pp. 57. [Fitted in envelope on back cover of Part I.] Complete, $2.50, postpaid, or Part II, 50c.

This is a pocket-book designed as a guide for mining engineers in the examination and report of mining properties. Part II is a separately bound book of blank forms for recording the data gleaned from examination. The directions and suggestions for the examination of mines, placers, and mining claims and titles occupy about 30 pages, while the other two-thirds of the book is composed of miscellaneous suggestions and information—classification of igneous rocks, study of ore deposits and several pages of cost data, tables of weights, measures, money, hydraulics, etc.

A Survey of the United States in 1910

ABSTRACT OF THE CENSUS—Statistics of Population, Agriculture, Manufactures and Mining for the United States, the States and Principal Cities. Thirteenth Census of the United States, Taken in 1910. Washington, D. C.: Bureau of the Census. Cloth; 10x12 in.; pp. 569.

Previous abstracts of the Census have been published as tables only, in octavo form. This one contains text as well as tables and is uniform in size and style with the other volumes comprising the Thirteenth Census. Interest and convenience alike have been served by combining tables and text on each of the subjects treated. Maps and diagrams are used to advantage .

The volume is in four divisions: Population, Agriculture, Manufactures, and Mines and Quarries. Besides the detailed contents there is an Index to Tables, which will be appreciated by those wishing to look up special figures.

It is interesting to note in passing that "the population living under the American flag" was "approximately" 110,100,000 in 1910. In the United States proper (excluding Alaska and all outlying possessions) there were 91,972,666 people in 1910. Of these, 46.3% are classed as urban (living in places of 2500 or more) and 53.7 as rural, as compared with 40.5 and 59.5%, respectively, in 1900, and 29.5 and 70.5 in 1880.

Under Agriculture, 12 pages are devoted to Irrigation and Irrigated Crops (for the year 1909). The total area reported as irrigated was 13,738,485 acres (not including rice irrigation), which was 1.2% of the total area of land in the states where irrigation was practiced, 3.5% of the land in farms and 7.9% of the improved land in farms. Irrigation works were available for supplying water to 19,334,697 acres in 1910, while the acreage covered by works completed or in progress was 31,111,142 acres. The irrigated areas included in these figures were located in 17 states.

The manufactured products of the United States (excluding Alaska, etc.) in 1909, were valued at $20,672,052,000 and were produced in 268,491 establishments by 7,678,578 wage earners, salaried employees, proprietors and firm members. Meat-packing houses, foundries and machine shops, lumber plants and steel-rolling mills led in value of products, in the order named.

Mines, quarries, petroleum and gas wells gave a product valued at $1,238,410,322 in 1909, or only some 6% of the value of manufactured products.

Finally, it may be noted that the Abstract, as here briefly noted, will be published in as many editions as there are states. Each State-Abstract will contain all the information given in the present volume, plus all the information gathered for that state except as to occupations. As there will also be groups of volumes on the four main divisions of the Census—Population, Agriculture, Manufactures, Mines and Quarries—it will be seen that the wants of most individuals and many libraries will be served by one or at most a few volumes, thus saving a large amount of shelf room in libraries and effecting no small economy to the government in printing, binding, storage and distribution.

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MANUAL OF WIRELESS TELEGRAPHY AND TELEPHONY—By A. Frederick Collins. Third edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xv + 300; 129 illustrations, $1.50.

Rapid progress in the art of electric-spark communication has necessitated frequent revision of all handbooks that aim to be guides to the practical manipulation of apparatus in service. That situation, probably as much as any universal acceptability which this work may have, explains the rapid succession of three editions. To many, the inclusion of wireless telephony in the title will appear a bit unfortunate. The section on this development is very short and almost exclusively describes Mr. Collins' work—which is under a shadow—because of association with unfortunate business manipulations.

For beginners in wireless telegraphy this manual is seemingly acceptable as it lives up to the self-imposed limitations of a rudimentary informational text of practical nature. First the simplest possible system is described and the theory of operation explained—largely by analogy. Then the apparatus seen in commercial stations is described and followed by notes on the necessary elevated structures which radiate the energy of signals. Wiring diagrams for sending and receiving circuits are interposed before some further theoretical discussions, of the actions in the several parts of sending and receiving systems. The proper adjustment and operation of these several instruments is later briefly set forth, previous to describing the different makes of equipment. This last named chapter has a historical outline of the development of the systems now seen in commercial form. The Marconi and Telefunken systems are described and the Lodge-Muirhead, Branly-Popp, Rochefort, Tissot, Popoff, Cervera-Baveria and DeForest systems are mentioned, but nothing is said of the Poulsen and Fessenden schemes, which are notable in some ways and more important, probably, than some of those above noted, though not developed to the extent of the Marconi and Telefunken. Under "Suggestions to Operators" is a lot of miscellaneous information on rates for messages, location of stations, signal alphabets and codes, company and government service instructions, etc. After the brief chapter on telephony, is a concluding glossary of terms and phrases.

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ON THE FEASIBILITY OF CONSTRUCTING A RESERVOIR IN PYMATUNING SWAMP, CRANFORD COUNTY, PENN.—Report of the Water-Supply Commission of Pennsylvania. Harrisburg, Penn.: Water-Supply Commission. Paper; 6x9 in.; pp. 79; maps and halftones.

As a result of surveys made by E. E. Haslam, under the direction of Farley Gannett, chief engineer, the commission concludes that a large part of the swamp named could be turned into a storage reservoir, 24.7 miles in area and 8,182,000,000 cu.ft. in gross capacity by building an earth dam with an average height of 27 ft. and a length of 2910 ft. A draft of 4.3 ft. in an average year and of 9 ft. in the driest year of the last 35 years, would give a minimum discharge of 450 sec.-ft. (against an actual 20 sec.-ft.) of low-water flow in the Shenango River, at Sharon. This would more than supply all the present industrial demands on the stream. The reservoir would also, the commission says, "eliminate any considerable contribution to floods from the 150 sq.mi. of territory tributary above the dam, which constitutes one-quarter of the area above shown and 18.7% of the area above New Castle. The reservoir would add about "2000 primary horsepower" on the Beaver River, and would increase the value of the river water for cooling purposes by reducing the high summer temperatures which now prevail. In addition the sanitary condition of the river would be improved. The estimated cost of the project is $1,600,000. A bill authorizing the Commission to construct the reservoir and appropriating $400,000 for taking land which would be flooded, has been introduced in the Pennsylvania legislature. The report is particularly interesting in view of the floods in the Shenango and Beaver rivers in March, 1913. (See also note on proposed flood protection work at New Castle, Penn., p. 756, "Eng. News," Apr. 10, 1913).

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The "Journal" of the American Institute of Architects is to be edited by C. H. Whitaker, who has been especially engaged for that service. In "Engineering News," March 13, 1913, p. 547, it was stated that the "Journal" was under the editorship of D. Knickerbacker Boyd. This was not entirely correct. Mr. Boyd served only in an advisory editorial capacity, the editing, up to the enlisting of Mr. Whitaker's services, having been in charge of Frank C. Baldwin, chairman of the Committee on Publications, and Glenn Brown, Secretary of the Institute.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AARDEN RESERVOIRDAMMEN—By A. A. Meyers, Ingenieur der 1e klasse bij den Waterstaat in Nederlandsch-Indie. Bijlage van het Archief voor de Suiker-industrie in Nederlandsch-Indië. Batavia, Nederlandsch-Indië: Algemeen Syndicaat van Suikerfabrikanten. Cardboard; 7x10 in.; pp. vii + 90; 45 illustrations.

ANALYTICAL MECHANICS—For Students of Physics and Engineering. By Haroutune M. Dadourian, Instructor of Physics, Sheffield Scientific School, Yale University. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xii + 353; 148 text figures. $3, net.

BEANSPRUCHUNG DER BAUSTOFFE IN STAUMAUERN NACH NEUEREN FORSCHUNGEN—By k. k. Baurat, Ziv.-Ing. Wilh. Plenker, Bauunternehmer in Prag. Wien: R. v. Waldheim, Jos. Eberle & Co. Paper; 7x11 in.; pp. 150; 21 text figures. 6 marks.